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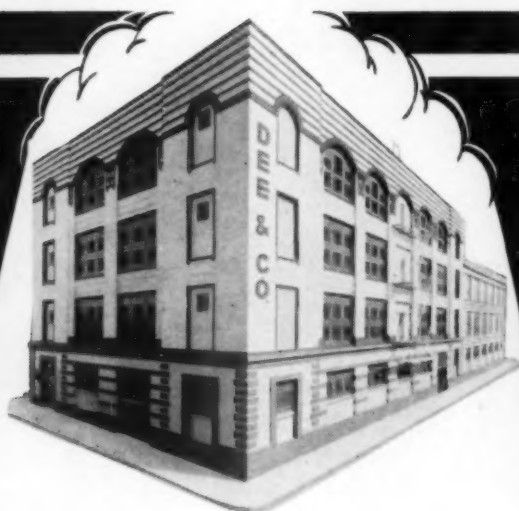
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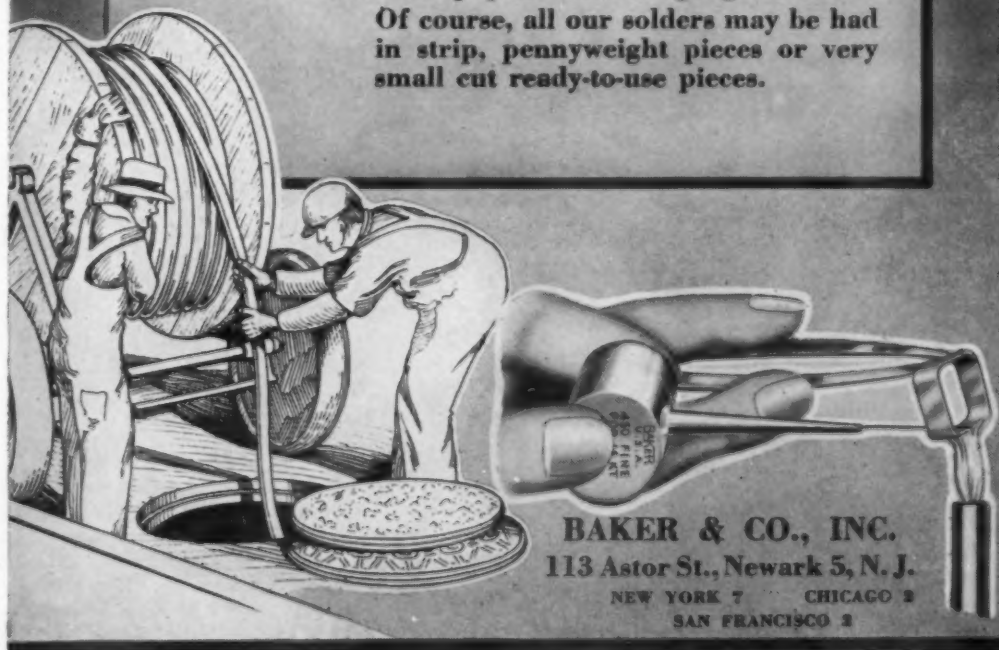
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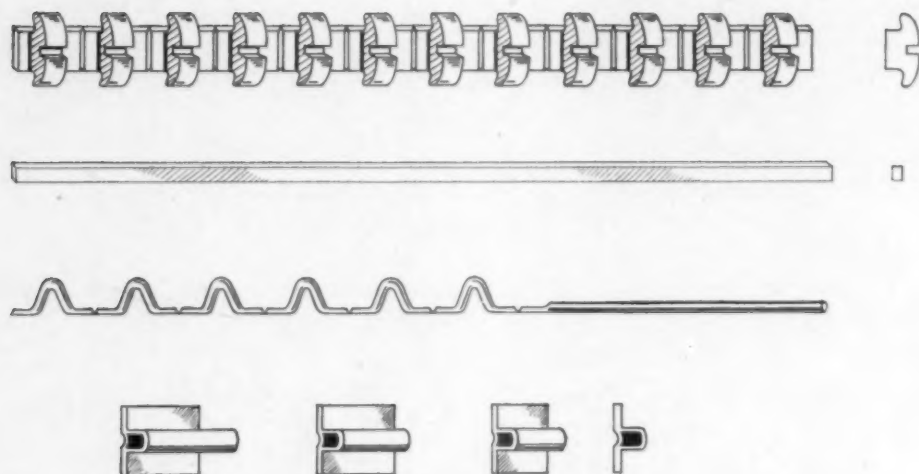
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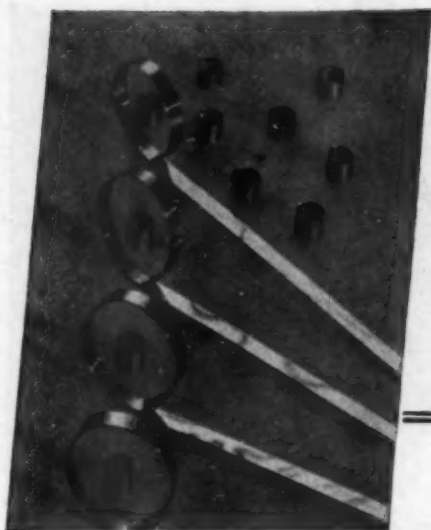
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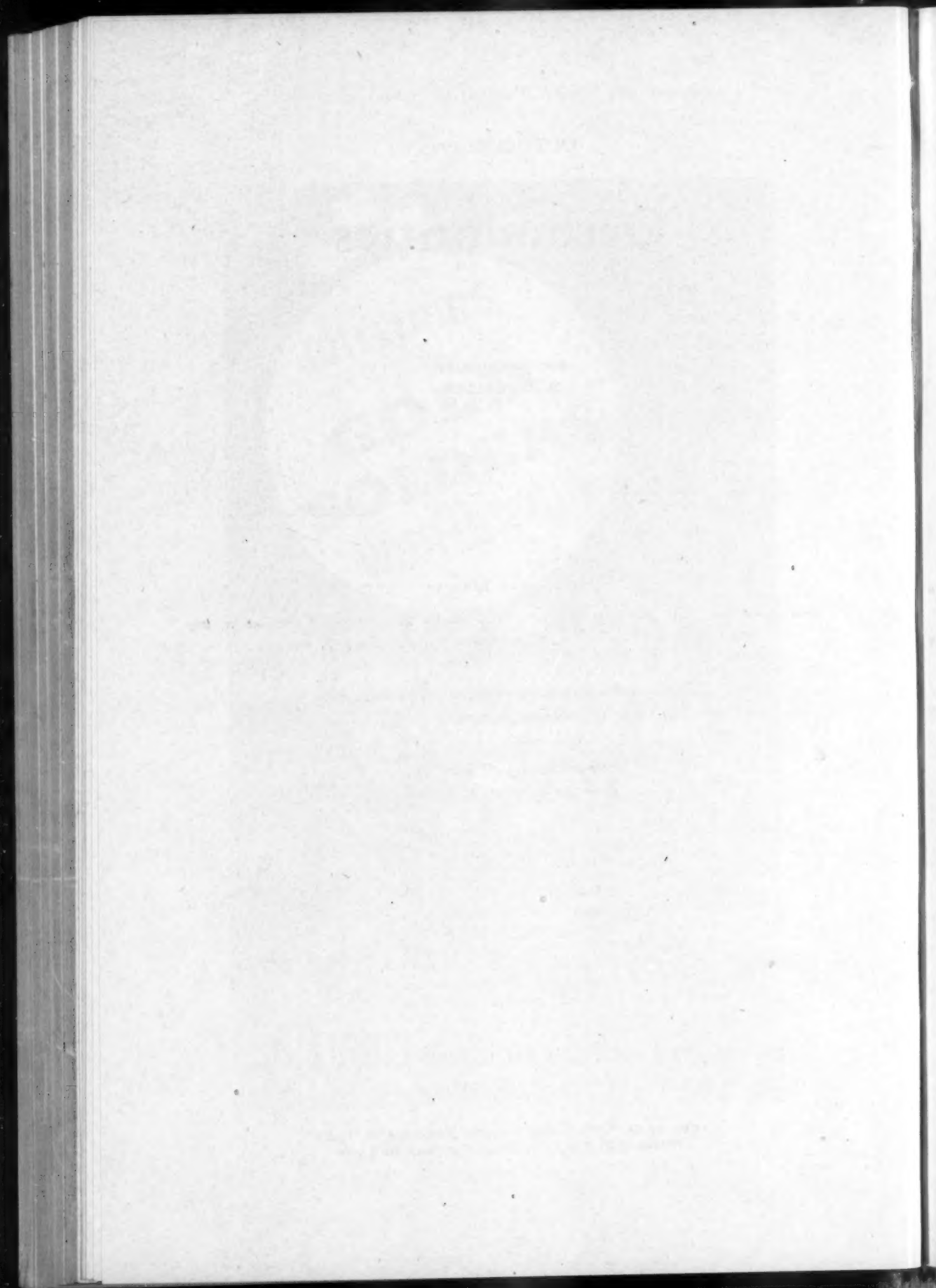
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Original Articles

THE STUDY AND DEVELOPMENT OF THE MUSCLES OF MASTICATION, THE TEMPOROMANDIBULAR ARTICULATION, AND THE STYLOID PROCESS

LEROY M. ENNIS, D.D.S.,* PHILADELPHIA, PA.

IF I were one of the wise men, I would speak to you in parables that would allow all to depart knowing that their thoughts regarding the temporomandibular joint were correct and that I was a really wise man. However, not being one of the ancients, I will make certain statements which will lead to discussion causing many to leave unconvinced, while others will leave with an open mind, thinking about the problem and trying to arrive at its solution. It is to the latter group that I wish to give a few thoughts heretofore not presented or discussed. It has to do with the development of the muscles of mastication, the temporomandibular articulation, and the growth and development of the styloid process and the muscles attached thereto, all contributing in adult life toward neurologic conditions in certain individuals.

Much has been written and much has been said about the roentgenologic study of the temporomandibular articulation. Yes, much has been written without much study or thought, for, during the last decade the temporomandibular articulation has been the subject of much discussion, most of which has been based on a few clinical facts and no scientific reasoning. Although the tendency of many investigators in the past two years is to return to a point where fundamentals and common sense are beginning to prevail, yet a few months ago I received a letter from a general roentgenologist in Texas, a former student in the Graduate School of Medicine, University of Pennsylvania, which contains the following:

One of our local dentists has asked me about a roentgen examination adapted to reveal the type of prosthesis required for each individual patient. He informed me that the slope of the temporomandibular articulation was very important in this connection, a fact of which I was in complete ignorance. . . .

*Professor of Roentgenology in the Thomas W. Evans Museum and Dental Institute, School of Dentistry, University of Pennsylvania; Professor of Dental Roentgenology, Graduate School of Medicine, University of Pennsylvania.

Read before the New York Society of Orthodontists, Nov. 13, 1944.

This reveals the state of mind of many general practitioners who are led to believe that the roentgenogram is a panacea for their problems.

It was in an effort to arrive at certain fundamental reasoning that the following study was projected, to determine facts which might be helpful and could be used later in the diagnosis of pains in and around the temporomandibular joint. When roentgenograms are being interpreted, the basic fact that we must keep before us is that no two individuals are alike; in fact, to go just a little further, different parts of the same individual vary. That short statement brings before us the results of the following study of normal development at birth. Realizing that form and function constantly modify one another, it was decided to study form before function had an opportunity to change or modify it.

In reviewing literature on the temporomandibular articulation, it was found that little comprehensive work had been undertaken to investigate the area except in the adult joint with a full complement of teeth. From this observation it was decided to start at birth with a study before any muscular development or function could be the cause of any abnormal development, with the thought later to dissect and x-ray cases at varying ages up to the point where the teeth are completely lost for a long period. When making such a study we must review the anatomy of the part, and we find that in the early embryo the head and neck are preceded by five visceral arches on either side, composed of cartilage and separated by four furrows. The first arch bifurcates into a superior and inferior process. The superior process unites with the intermaxillary portion of the nasofrontal process and becomes the superior maxillary bone; the inferior process becomes the mandible. Meckel's cartilage, which is in the first visceral arch, forms the malleus, the incus, and the stylomandibular ligament. The second arch forms the arch of stapes, styloid process, stylohyoid ligament, and the lesser cornu of the hyoid bone. The third arch forms the greater cornu of the hyoid bone, while the fourth and fifth fuse to form the neck.

The maxillary bone and the mandible, once formed, are held in normal relationship only by ligaments attached to both and known as the temporomandibular articulation, which is a ginglymo-arthrodial joint formed by the anterior portion of the mandibular fossa of the temporal bone and the articular tubercle above, and from below the condyle of the mandible held in position by the articular capsule, temporomandibular ligament, the sphenomandibular ligament, the articular disk, and the stylomandibular ligament. This joint has extensive movements. The mandible may be depressed or elevated, or carried forward or backward, as well as given a slight amount of side-to-side movement.

The mandibular fossa (glenoid fossa) is a deep hollow on the underside of the squamous portion of the temporal bone, its greatest diameter running transversally, but passing somewhat forward and outward. At birth the mandibular fossa is nearly flat and the eminentia articularis only slightly raised. The fossa gradually deepens due to function (Fig. 1).

By studying the articulation at birth, it was possible to study the joint at maximum development, when the jaws had not functioned, so that we can assume any variance in the right and left joints is due to development and not as a result of attrition, habits in chewing, or unbalanced occlusion. After developing a technique which would allow making roentgenographic studies with as little distortion as possible, the procedure was as follows: The skin and fascia were removed from the side of the head, after which the muscles of mastication were dissected out and much attention was given to note any variance

in the attachment of these muscles. As each muscle was dissected it was carefully covered with three thicknesses of 0.005 tin foil and x-rayed so that the origin and insertion are clearly shown (Fig. 2).

The muscles were removed, leaving only the joint and the ligaments which were all well developed. In order to examine the meniscus the ligaments were removed and then, of course, the mandible separated from the mandibular fossa showing the paperlike meniscus on the head of the condyle.

In the resultant roentgenograms it is interesting to note the well-developed meniscus which has a tendency to cling to the head of the condyle when the mandible is removed (Fig. 4).

Fig. 1.

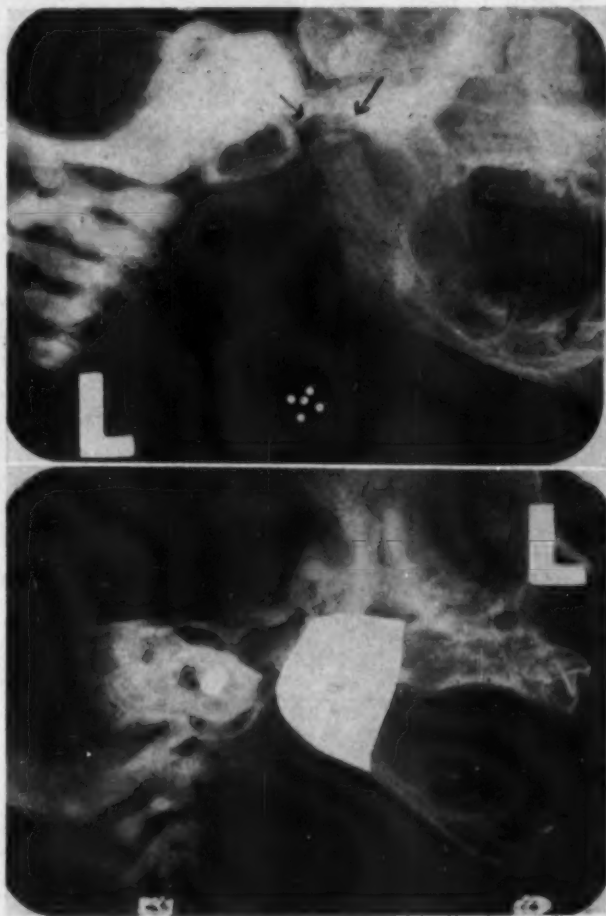


Fig. 2.

Fig. 1.—Illustrating the nearly flat glenoid fossa, and the eminencia articularis only slightly raised at birth.

Fig. 2.—Illustrating the result of covering the muscle with tin foil in order to opaque the object in the roentgenogram. Here several thicknesses of 0.0005 foil were used. By eliminating some of the foil the object may still be seen in its correct size, but in relationship to the underlying structures as seen in some of the following illustrations.

The eminential plane at this stage of development makes an angle with the horizontal of only 18 degrees; it passes downward and forward at a slight angle. This obtuse angle represents the state of development of the eminentia at this age (Fig. 1).

The heads of the condyles are fairly well developed but, like other bones at this age, poorly calcified. It was of great interest to note that the long axis of the heads of the condyles as made with the sagittal plane extended medially and

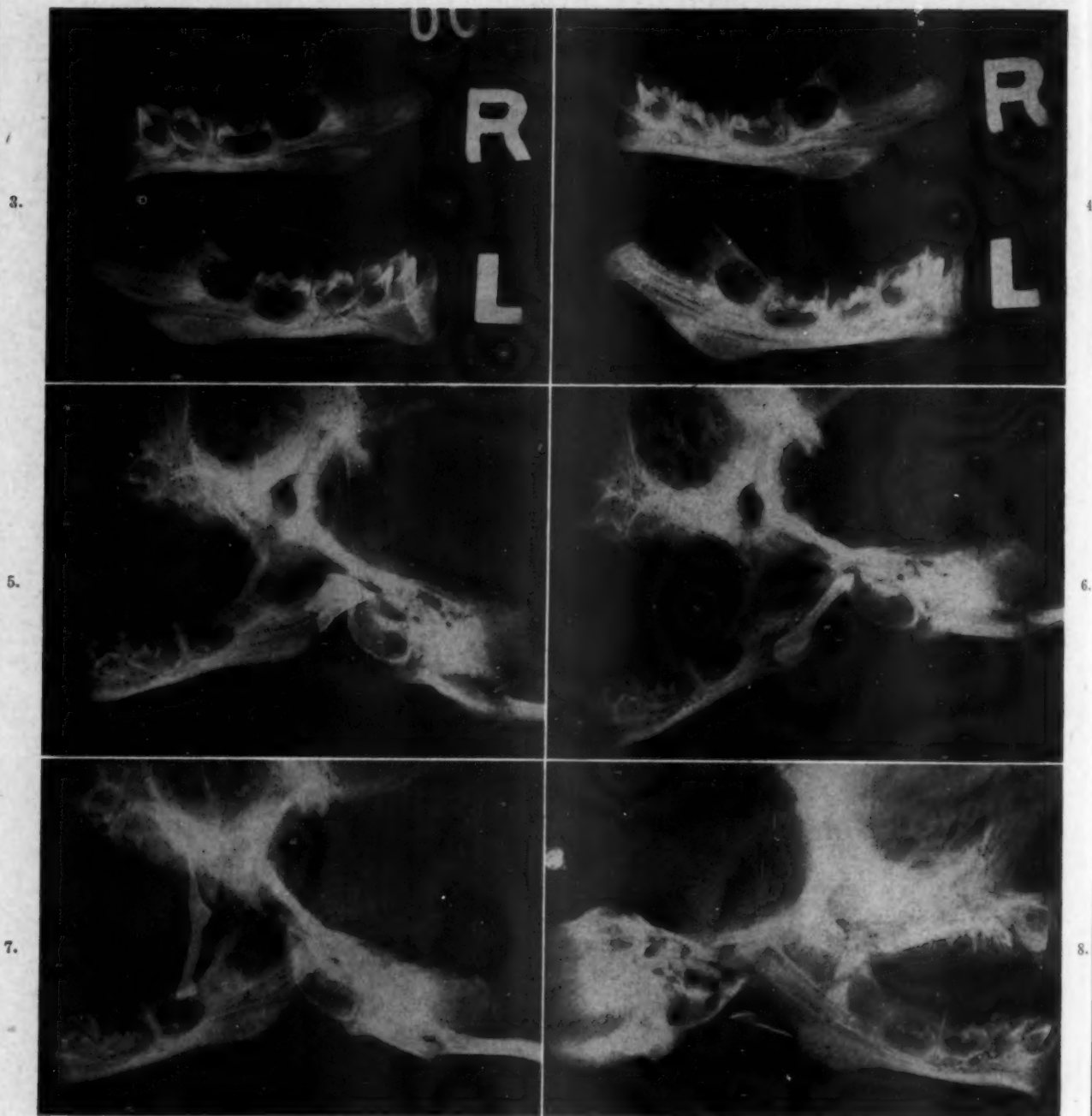


Fig. 3.—Illustrating the variation in size and form of the heads of the condyle, in the same individual at birth. The condyle on the right side is rather flat and broad, while the one on the left is more rounded and in general not as wide.

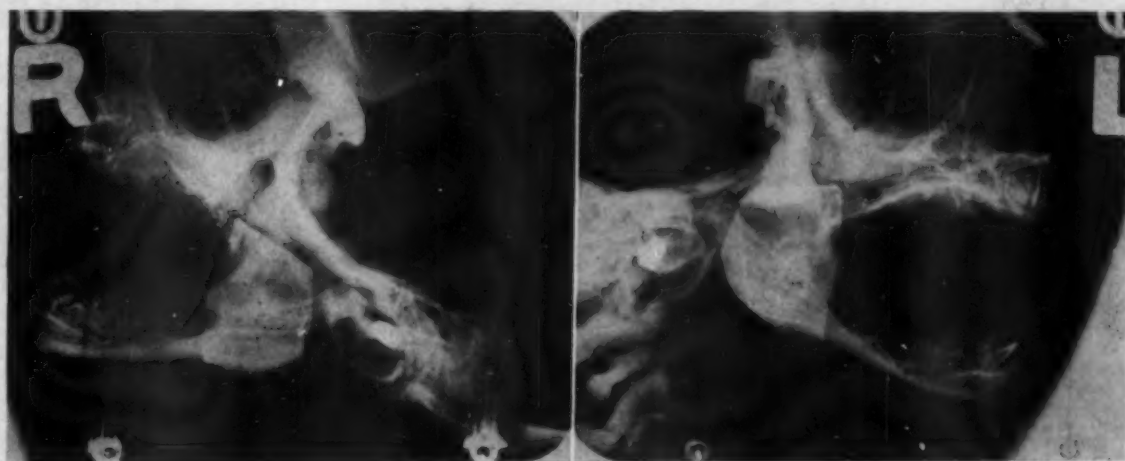
Fig. 4.—The roentgenogram of the left mandible shows the slightly radiopaque meniscus clinging to the head of the condyle, while the roentgenogram of the right condyle shows a definite radiolucent line similar in character to the epiphyseal line seen in the long bones.

Fig. 5.—Reveals the size and relationship of the capsular ligament to the head of the condyle and the temporal bone.

Fig. 6.—Reveals the temporomandibular ligament extending from the lateral surface of the zygoma to the body of the ramus.

Fig. 7.—Showing the sphenomandibular ligament extending from a spine of the sphenoid to the body of the mandible. In the adult it is attached to the lingula.

Fig. 8.—Showing the stylomandibular ligament extending from the styloid process to the mandible.



A.

B.

Fig. 9.—A and B, Showing the right and left side of the same head, illustrating the position of the masseter muscle and definitely showing a difference in size of the muscle in the same individual.

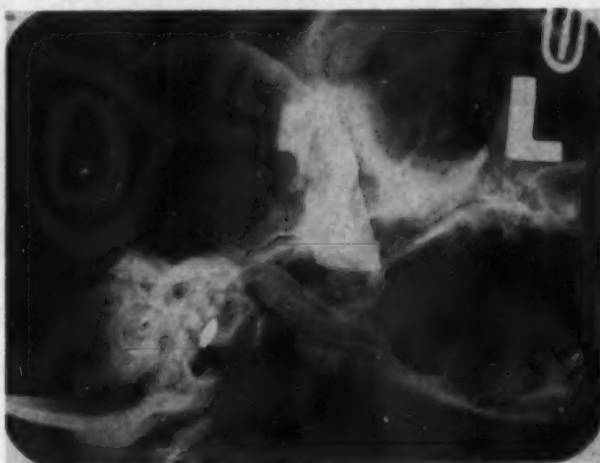
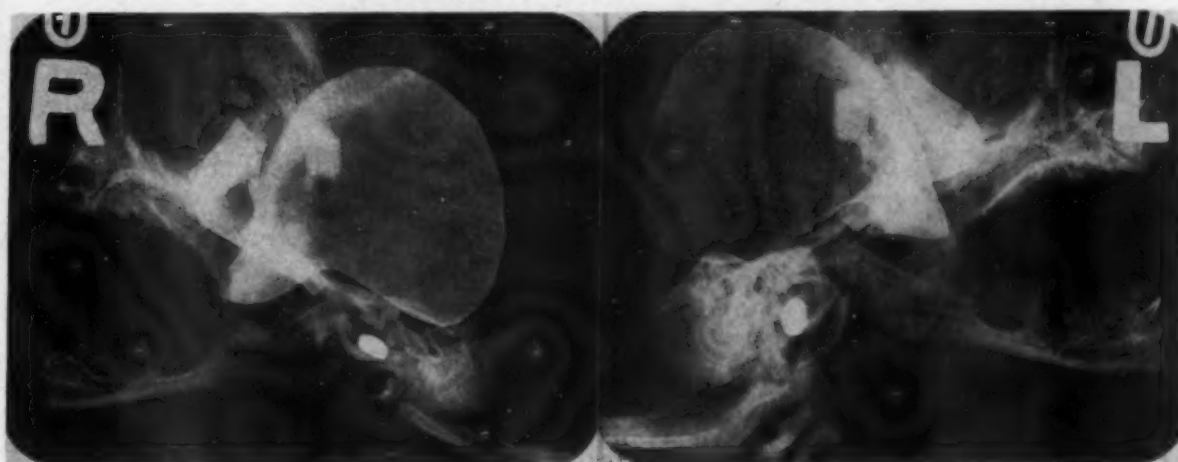


Fig. 10.—Showing the relationship of the temporal muscle to the mandible at birth.



A.

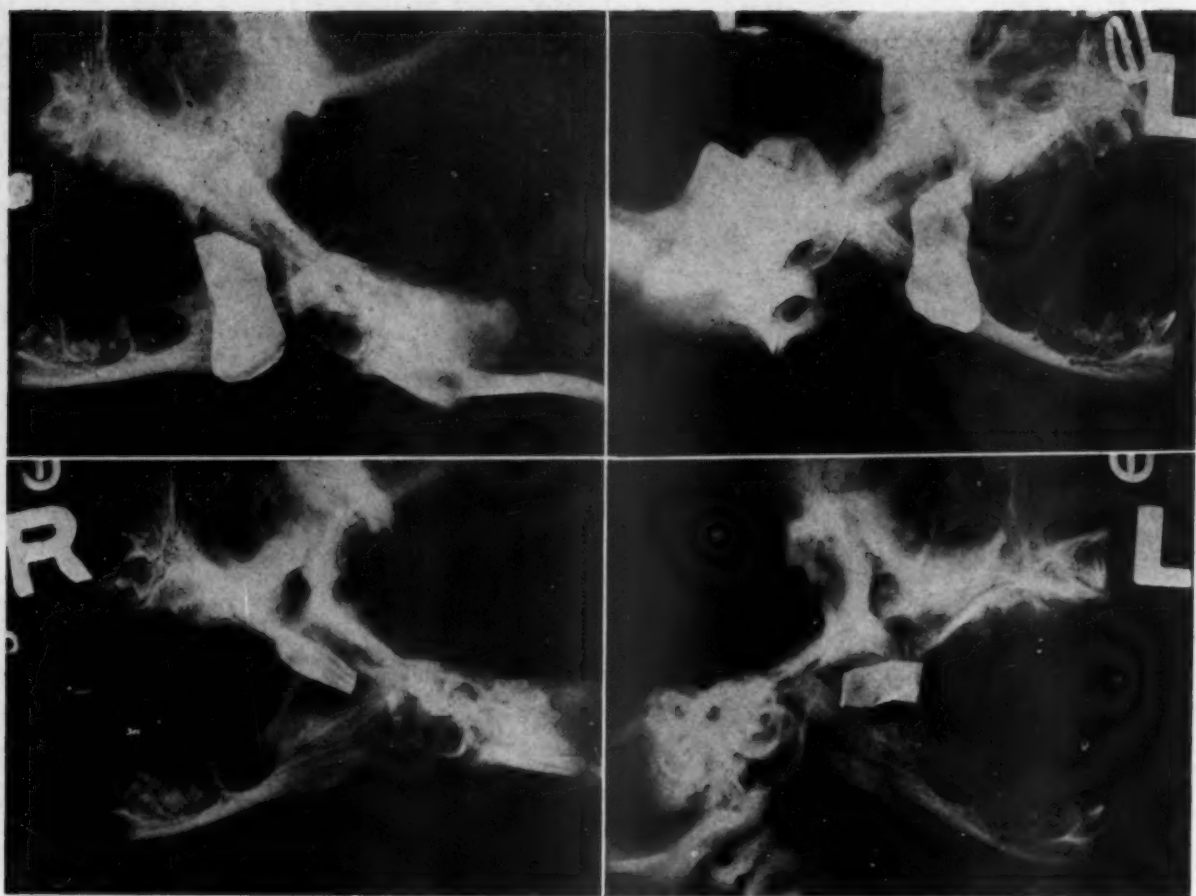
B.

Fig. 11.—A and B, Showing the right and left side of the same head; illustrating the position of the temporal muscle, its relationship to the zygoma which has been opaqued, and its insertion on the coronoid process. Note also the difference in size of the right and left temporal muscles.

A.

Fig. 12.

B.



A.

Fig. 13.

B.

Fig. 12.—A and B, Showing the dissimilarity in size and form of the internal pterygoid muscles of the right and left side of the same individual at birth.

Fig. 13.—A and B, Showing the dissimilarity in size and form of the external pterygoid muscles of the right and left side of the same individual at birth.



Fig. 14.—Showing the styloid process usually described as average. It is thick at its origin and tapers to a point.

slightly backward but varied with the right and left side of the head. Since the jaws never functioned, we assumed that this variation was due to asymmetrical development and not as a result of habits and masticatory function (Figs. 3 and 4).

Fig. 15.



Fig. 16.

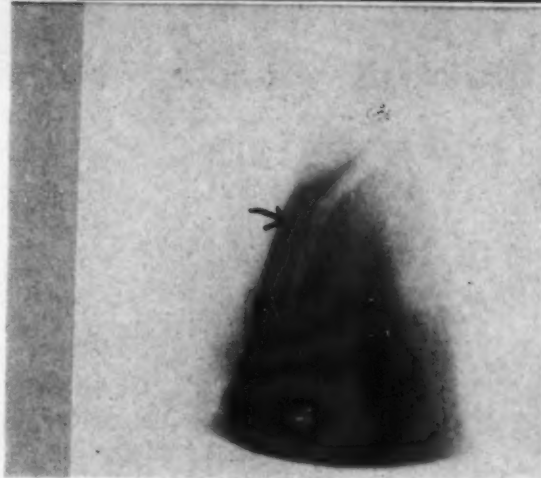


Fig. 17.

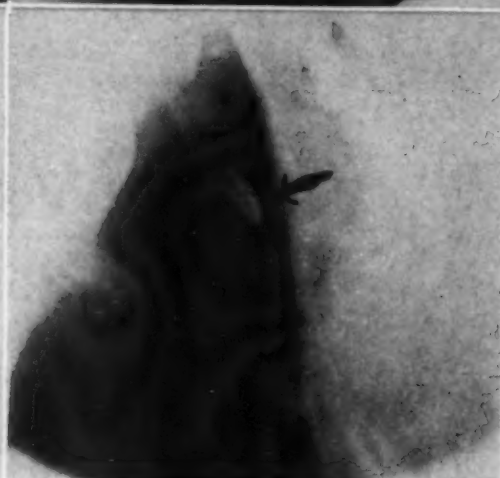


Fig. 18.

Fig. 15.—Illustrating a long styloid process, tapering to a very fine point and extending almost to the angle of the mandible. The styloid mandibular ligament in this instance would be very short.

Fig. 16.—Here the styloid process is about the same thickness throughout its entire length. The tip of the process is not as well calcified as the base.

Fig. 17.—Showing the styloid process to have been fractured and recalcified causing the process to have a bend backward and downward.

Fig. 18.—Revealing a fracture of the tip of the styloid process.

The ligaments at this age are surprisingly well developed. The capsular ligament, especially, forms a dense covering over the head of the condyle which firmly holds the condyle attached to the temporal bone and encloses and protects the joint. It is attached above to the circumference of the mandibular fossa and below to the neck of the condyle (Fig. 5).

The temporomandibular ligament is present and runs from the lateral surface of the zygoma to the neck of the condyle (Fig. 6).

The sphenomandibular ligament runs from the spine of the sphenoid down to the lingula (Fig. 7). This is very well developed at this age in proportion to other structures because at birth the mandibular foramen and lingula are very low in the ramus about in line with the middle of the body of the mandible.

The stylomandibular ligament extends from the styloid process to the posterior border of the ramus and is the least developed of all (Fig. 8).

Fig. 19.

Fig. 20.

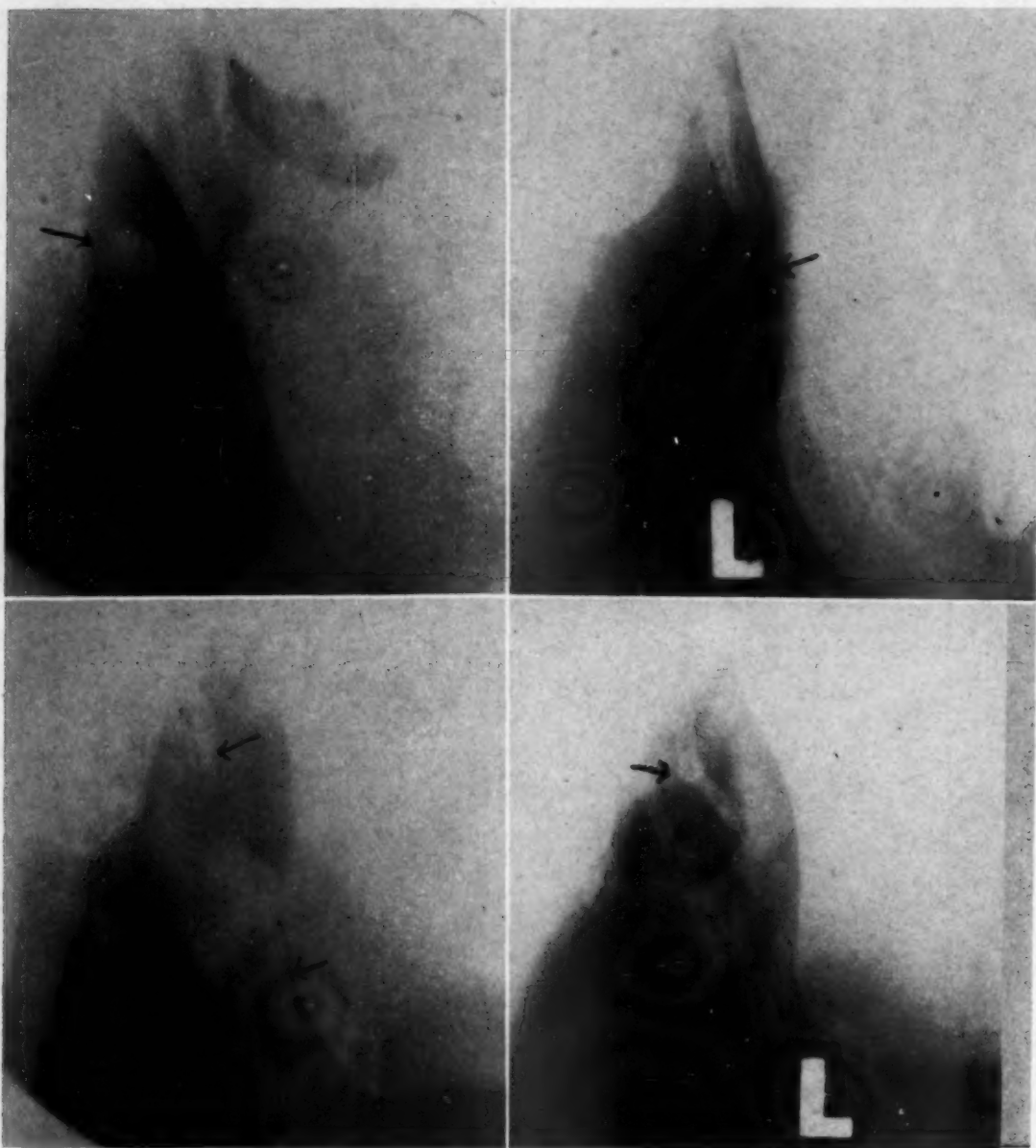


Fig. 21.

Fig. 22.

Fig. 19.—Here the styloid process has been fractured at its base. The entire process has been pulled downward and forward by the attached muscles.

Fig. 20.—Showing a fracture of the tip of the styloid process which has been pulled downward and forward from the main body of the process, and superimposed partly over the ramus.

Fig. 21.—Showing a fracture of the styloid process, the lower fragment having been pulled down to the angle of the mandible.

Fig. 22.—Showing a healed fracture of the styloid process, the lower half extending forward forming a decided angle with the upper half. In this case the hyoid bone extends rather high in the region.

The posterior border of the ramus passes upward and backward at an angle of 45 degrees and the masseter muscle is inserted along this posterior border up to the neck of the condyle and also over the angle and about one-third of the distance along the lower border of the body of the mandible (Fig. 9, *A* and *B*).

The temporal muscle extends upward only to a line on a level with the supraorbital ridge, but is developed well and is normal in other respects (Fig. 10; Fig. 11, *A* and *B*).

The internal and external pterygoid muscles are both normal at this age, but it was noted that the attachment fibers of the external pterygoid to the meniscus were slight (Fig. 12, *A* and *B*; Fig. 13, *A* and *B*).

Probably the most outstanding revelation was that the muscles of mastication are dissimilar in the same individual and that the condyle of the mandible varies in the same individual at birth.

The knowledge of the blood supply of the temporomandibular articulation is of great importance when considering pain in this area, for congestion at this point will give rise to symptoms which are often attributed to position of the condyle.

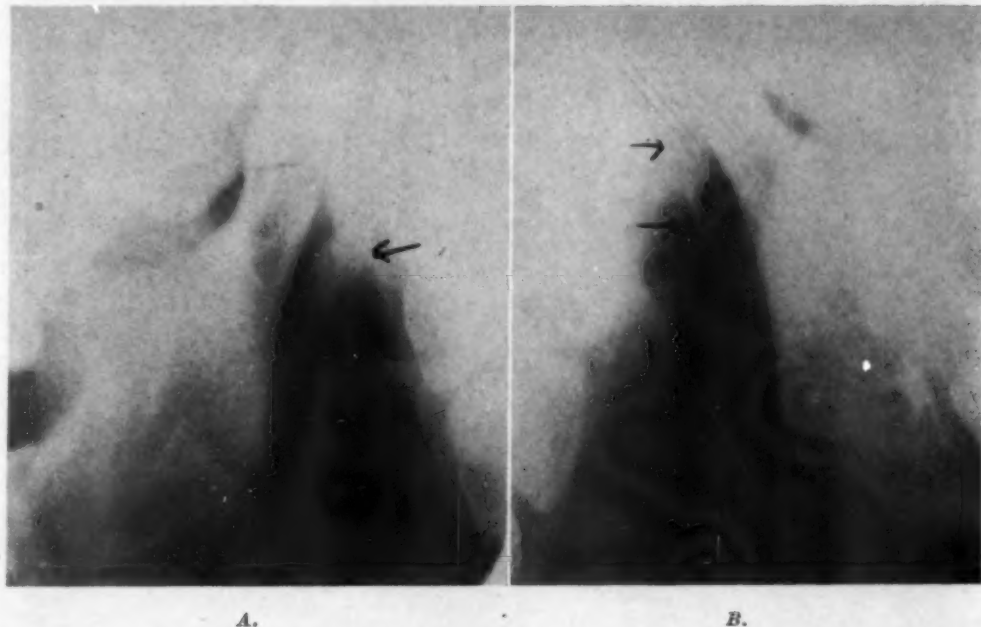


Fig. 23.—*A* and *B*, Showing the dissimilarity in size and form of the styloid process of the right and left side of the same individual. *A*, The right side caused a small swelling to appear on the external surface of the neck posterior to the ascending ramus, which was being treated with x-ray therapy.

When considering the blood supply, we must start with the internal maxillary artery which has three branches; of interest to this subject is the mandibular branch, which in turn has five branches, two of which are, namely, the deep auricular which passes behind the temporomandibular articulation, and the tympanic branch which gives off branches to the temporomandibular articulation but continues on to supply the mucous membrane of the inner ear.

The auriculotemporal nerve supply passes upward through the parotid gland between the temporomandibular articulation and the external ear. The articular branches of the auriculo temporal nerve are one or two delicate filaments which enter the posterior portion of the temporomandibular articulation.

Further study of this region leads to an important structure in the general anatomic construction in this area, about which very little has been written. When dealing with the subject of pain in this area, we cannot overlook the styloid process and the muscles attached thereto.

The styloid process is a part of the hyoid bar of the second visceral arch of the embryo. It begins as an ossification of a distinct piece of cartilage, but joins the petromastoid. It is thick at its origin but presently becomes thinner and ends in a sharp point (Fig. 14). It is usually about an inch long, but varies greatly (Figs. 15, 16, 17, and 18). It runs downward, forward, and inward and is continued as the stylohyoid ligament to the lesser horn of the hyoid (Figs. 19, 20, 21, 22, and 23). Three muscles, the styloglossus, stylohyoid, and stylopharyngeus diverge from it to the tongue, the hyoid bone, and the pharynx.

The deep layer of the masseteric fascia is connected internally with the styloid process and joins the deep cervical fascia below. A thickening of this deeper layer forms a flat band, the stylomandibular ligament which passes downward and outward from the styloid process to the angle of the jaw.

Fig. 24.



A.

Fig. 25.

B.

Fig. 24.—Showing the maxillary third molar in contact with the mandibular second molar at an angle of 45 degrees. This condition was evidently the cause of the mandible's shifting $\frac{1}{2}$ inch from center in five years.

Fig. 25.—A, Showing the condyloid process on the right side of case in Fig. 24, mouth closed.

B, Showing the condyloid process on the right side, mouth open, same case as Fig. 24. The condyle is in proper position and is well developed.

The stylohyoid is a slender spindle-shaped muscle which arises from the upper portion of the styloid process and passes obliquely downward and forward to be inserted into the base of the greater cornu of the hyoid bone, its nerve supply being the digastric branch of the facial nerve.

The stylopharyngeus arises from the inner surface of the styloid process near its base, its nerve supply being a branch of the glossopharyngeal.

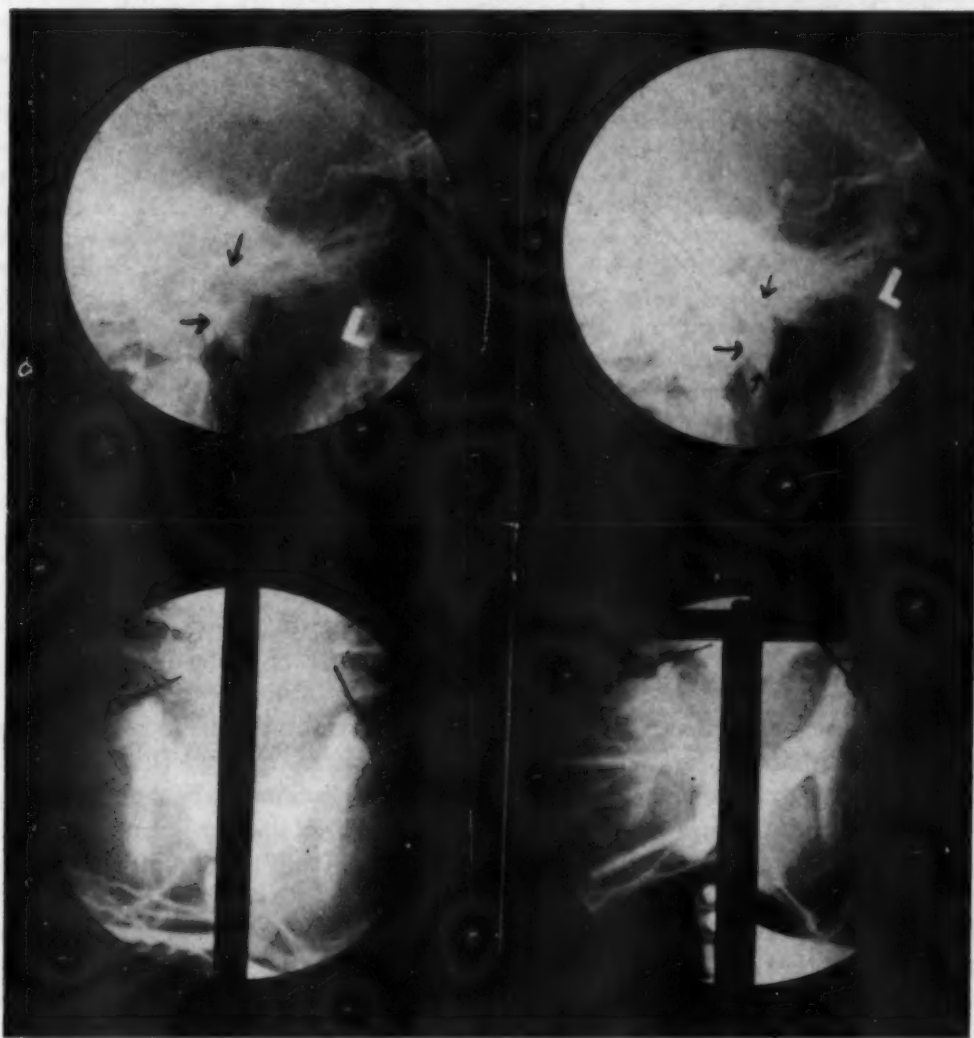
The styloglossus arises from the tip of the styloid process and from the beginning of the stylomaxillary ligament. It is a small ribbonlike muscle with an anterior and posterior surface, but as it descends it twists so as to lie along the outer side of the tongue, its nerve supply being the hypoglossal.

Having found by this study that there is an asymmetrical development of the mandibular fossa, the condyloid process, and the muscles of mastication,

A.

Fig. 26.

B.



A.

Fig. 27.

B.

Fig. 26.—Same as case seen in Fig. 24, except this reveals the left side of head. *A*, The mouth is closed; *B*, the mouth is open. Note the difference in the size and form of the head of the condyloid process. This denotes that as the head of the condyle goes forward it also rotates and, therefore, is not in the same plane as when the mouth is closed.

Fig. 27.—Same as case seen in Fig. 24. This, however, is a vertical view of the head of the condyle. *A*, The mouth is closed; *B*, the mouth is open. Note the difference in angulation of the heads of the condyle with the sagittal plane of the head, represented by the black in center of the illustration.

it is not difficult to believe, neither are we assuming too much to say, that this condition continues in probably the same proportion throughout life. If the muscles of mastication are larger and therefore capable of exerting a greater force on one side than the other, it is only simple logic that the force applied to the mandibular fossa through the condyloid process will cause developmental changes in these anatomic structures in direct relationship to the applied force. The mandibular fossa, nearly flat at birth, and the eminential plane, which makes an angle with the horizontal of only 18 degrees, also develop in depth and height, the fossa developing deeper and the eminentia developing an acute angle, giving it greater height. It can therefore be said that in the adult we may have a greater or lesser asymmetric development, for other factors now enter the picture, habits of chewing and unbalanced occlusion.

To illustrate that other factors have a great influence on the temporomandibular articulation, we present the case of a young woman 28 years old. She was found unconscious late in the evening in a motion picture theatre and was removed to the hospital. Upon regaining consciousness and upon examination it was found that her lower jaw was about $\frac{1}{2}$ inch off center. Upon further questioning it was found that she had had an appendectomy about five years before, and on checking her hospital record for that period her history showed that her mandible was about $\frac{1}{4}$ inch off center. In other words, her jaw had shifted $\frac{1}{4}$ inch. Now, five years later, it was $\frac{1}{2}$ inch off center. X-ray study of the right side showed the maxillary third molar at an acute angle (Fig. 24). As little knowledge can be obtained from one view, that is, one plane, others were taken. In Fig. 25, *A*, the mouth being closed, we find the condyle in proper position, but when the mouth is opened, Fig. 25, *B* we find the condyle in the classic relationship to the eminentia articularis.

The opposite side, however, shows something entirely different. Here we have the jaws closed Fig. 26, *A* and the mouth opened, Fig. 26, *B*. Interest must now be directed to the change in the size and shape of the shadow of the head of the condyle. It has the general shape of a football. This, of course, is due to the rotation of the condyle as the mouth opens. Further examination of the condyle in a vertical position reveals the relationship of the long axis of the head of the condyle to the sagittal plane of the head. Fig. 27, *A* shows the relationship with the mouth closed, and Fig. 27, *B* with the mouth open.

From what we now know as fact, we must realize that to define the normal temporomandibular articulation from the roentgenogram is beyond our limitations. The question may be asked, what is normal? And when it is defined, we can immediately show many cases that are not covered by the definition, yet must be classed as normal for that individual. It must be realized that much has been said and written about this articulation by clinicians who have only the roentgenographic picture of the patient when or after they are complaining of some discomfort or pain in the general area. I am afraid the symptoms lead the clinician to an interpretation of the roentgenogram. To say that the head of the condyle should be in a certain relationship to the eminentia articularis, or so many millimeters this way or that, to be normal in the roentgenograms, is a misstatement of fact, for, taking any group, young or old, we find many who can pull the head of the condyle anterior and free from the eminentia articularis. It is a normal procedure for that individual.

To summarize, the problem of the temporomandibular articulation is a complex one. Much of our present knowledge applied to treatment has been empirical, and before we arrive at a point where we are able definitely to place the cause of pain in this region on a definite focus, much more study and research will be necessary.

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THE RELATIONSHIP OF ORTHODONTICS TO GENERAL PRACTICE

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THE three main afflictions of the dental apparatus are tooth decay, pyorrhea, and malocclusion of the teeth.

We, as a profession, devote almost all of our attention to these three conditions.

If we neglect any one of them, we will fail in our one grand object, namely, the promotion and maintenance of healthy normal occlusion. For example, if we treat decay by filling the teeth, but neglect pyorrhea and malocclusion, the general health and appearance will suffer and the teeth may or should be lost. If we neglect treatment of decay and malocclusion, pain, root abscesses, and pyorrhea will occur; the general health and appearance will suffer and the teeth will be lost. Again, if we neglect only the treatment of malocclusion of the teeth with its associated jaw deformities, decay and pyorrhea will be more pronounced than they would be otherwise and the general appearance and health will suffer and the teeth will be lost.

These examples show how each branch of dental practice is dependent for its success on the other branches.

Prosthetic dentistry, the remaining branch, depends for its existence mainly on the failure of the three aforementioned branches.

In our busy lives of strenuous physical exertion, spent in treating dental ills, we have little time and mental energy remaining to devote to serious and sustained consideration of the problems of how, when, and why civilized man became so dentally degenerate and what may be done to arrest the present stage of degeneration and prevent even further degeneration in the future.

Our primitive uncivilized ancestors were almost free from tooth decay and pyorrhea and had much less malocclusion with its associated jaw deformities than we have.

This freedom from dental afflictions was not due to their good management or to any conscious and planned effort on their part to prevent dental afflictions.

Let us now consider briefly something of the nature of primitive uncivilized man's diet and the part it played in the development of his dental apparatus and the maintenance of its health. Such a consideration may throw some light

on the causes of present-day civilized man's dental afflictions. It may also suggest means of lessening these afflictions.

Before primitive man learned to use fire for cooking and to grind harder substances such as cereals between stones to soften them, his food contained hard tough muscle fibers in animal food and hard coarse fibers in vegetable food.

The food was not concentrated as our food is, so that a large amount had to be eaten to obtain sufficient nourishment. This meant that the teeth had to grind harder and for a longer time each day. This diet, which also contained grit which he was unable to separate from his food, caused wearing away of the teeth, both on the chewing surfaces and in between the teeth. Even after primitive man cooked his food and used stones to grind it, his food still contained hard, coarse, fibrous and gritty substances which produced the same occlusal and interproximal attrition.

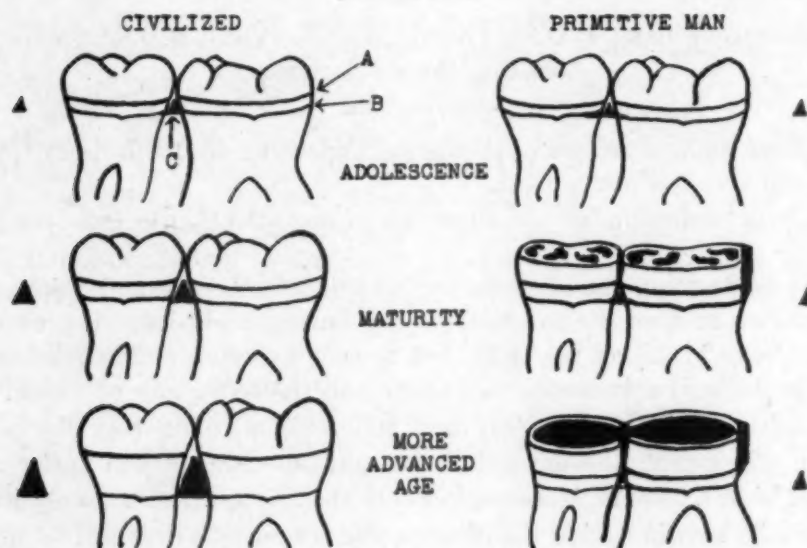


Fig. 1.—Diagrammatic comparison of the changes at different ages of the teeth and gums of primitive man and civilized man to show how primitive man remained free from pyorrhea and civilized man develops progressively worse pyorrhea as he gets older.

The triangles indicate the relative sizes at different ages of the interproximal space, the space where pyorrhea develops if the gingival trough is deep enough. The diagrams also show how primitive man through attrition, and the food which caused it, remained free from caries, whereas caries may develop in the susceptible areas (occlusal and proximal surfaces and gum margins) in civilized man because of lack of tooth attrition. Ungulata, Rodentia, etc., are also dependent on attrition for normal dental development.

A, Free gum margin. B, Level of soft tissue attachment to tooth. C, Interdental gum papilla. A→B, Height of gingival trough.

This wearing away became so marked that in some of the older individuals all of the crowns of the teeth wore right off. In some molar teeth the wear extended below the bifurcation of the roots so that one tooth became more than one (e.g., two separate roots of a molar). Deposition of secondary dentine in the pulp chambers and root canals kept pace with the wearing of the teeth so that the pulps did not become exposed except in some of the more extreme cases of wear.

Primitive man's teeth always had attrition because he could get no food which would not cause it.

To compensate for attrition, the teeth kept on erupting throughout life. If this continuous eruption had not taken place, the teeth would soon have been worn right down to the gum margins, leaving useless tooth roots embedded in the gums and jawbones. That continuous eruption evolved to compensate for attrition first occurred to the writer in 1938 while observing the orthodontic problem

of changes in occlusion from infancy to old age in museum specimens of Australian aboriginal skulls. This suggested that studies in attrition should throw light on the causes of pyorrhea and decay.

Let us now consider decay of the teeth in relation to civilized man's food and teeth. G. V. Black pointed out and it is now well known that there are certain well-defined places on the teeth where decay occurs, and that, except for these particular places, the surfaces of the teeth are almost, if not entirely, immune to decay.

The places where decay occurs are where food collects and remains, namely, the occlusal surfaces of molars and premolars, the proximal surfaces and the gum margins of all of the teeth. All other surfaces are self-cleansing and remain free from decay.

It will be noticed that two of the three above-mentioned places where decay occurs in civilized man are the very places where attrition takes place in primitive man's teeth. Very soon after the eruption of primitive man's teeth the deep pits and developmental grooves on the occlusal surfaces become worn and shallowed out by the everyday continual chewing of hard, coarse, fibrous, gritty food, and at the same time, the points of the cusps were being worn away so that for the short time in youth before the deep grooves were quite worn away, any starchy fragments of food which may have lodged in these deep grooves and pits were very soon swept away and therefore did not remain long enough to ferment and start decaying the teeth. After the enamel was worn flat and dentine was exposed, the flat chewing tooth surfaces collected no food.

Also, starches could not remain, as they do in civilized man, below the interproximal contact points of the teeth which were being continually worn by the rubbing of the approximating teeth against each other. Therefore, what were contact points just after tooth eruption soon became new or renewed tooth surfaces with large contact areas through continual wearing and changing.

At the necks of the teeth at the labial, buccal, and lingual gum margins, decay did not occur as it does in civilized man because, as the teeth continually erupted and wore away on the occlusal and incisal surfaces through food chewing, the food slid over the sides of the occlusal surfaces and pressed against the gums and wore the gum margins away so that the free gum margins continually receded.

Therefore, the part of the tooth which was at the gum margin at an early stage of wear moved up occlusally, as it were, and a new and lower level of the tooth became the new surface at gum margin level at a later stage.

Therefore, if ever the minutest amount of tooth decay did start at gum level, it soon became "arrested decay" as that level of the tooth moved on occlusally and became a so-called self-cleansing area and was replaced by some of the tooth which was formerly below the free gum margin.

On the other hand, in modern civilized man we have what is called gingival third decay because the free gum margin remains more or less at the same level throughout life although our teeth continually erupt as did our primitive ancestors'. But there is practically no occlusal wear of our teeth. We chew on stilts, as it were, so that the food we chew does not press down and wear away the gum.

Therefore, we get a deeper and deeper gingival trough with the free gum margin of this trough at more or less the same level throughout life.

Since beet sugar and cane sugar have been extracted and used by civilized man, decay has increased enormously. In those countries where consumption

of this "free" sugar is highest (Australia and the United States), the incidence of decay is the greatest. Published results by workers on this problem show that acid is formed in the food retention areas of teeth three minutes after free sugar is taken into the mouth, whereas other carbohydrates take fifteen minutes. With the severe sugar rationing in England in World War I, decay fell from a high to a low incidence. A similar great fall has been observed in England during World War II. The elimination of free sugar would go far in helping to solve the problem of decay prevention.

Australian aborigines who have not previously come in contact with white men dislike our sugar-sweetened food, but they soon acquire the taste for it.

Will fluorine as a mouthwash after meals, which would permeate the enamel, thus inhibiting enzymes in the saliva, prevent decay by preventing acids forming from carbohydrate fermentation?

Of what value is the toothbrush in preventing decay? Undoubtedly, much decay on occlusal surfaces and at the gum margin is prevented by tooth brushing, but even one bristle of the brush cannot penetrate to the depths of the steep, narrow developmental grooves and pits on the occlusal surfaces of the teeth, so that decay starts and spreads from these places in newly erupted teeth regardless of how skillful and conscientious the parents, children, and dentists are.

Similarly, the toothbrush cannot properly penetrate just below the contact points to prevent proximal decay.

Chewing apples after meals, although it does good, has its limitations, because, just as in the case of the toothbrush, the three above-mentioned parts of the teeth which are most difficult and often impossible to clean are the places where cleaning is most necessary.

Primitive man required no conscious effort on his part to prevent decay because tooth wear and the food which caused it kept clean all the places which on civilized man's teeth are food retention areas.

It seems that the process of deposition of secondary dentine, which is regarded in dental textbooks as having been designed by Nature to wall off decay from exposing the pulp, evolved in response to quite a different thing altogether from decay; it evolved probably entirely in order to prevent pulp exposure by tooth wear, because decay was a rarity and tooth wear was never absent.

Now let us consider pyorrhea (which is almost always present in modern civilized adults) in relation to the teeth and diet of primitive man.

As has been previously mentioned, the teeth of primitive man were continually wearing away on the chewing surfaces and in between the teeth. To compensate for this wear, the teeth evolved, by a process of natural selection (which process we will not attempt to discuss at present because of time shortage), to the shape and form found in primitive skulls. This shape and form are the same in civilized man except for slight changes which, for our present consideration, are negligible.

To withstand wear of the teeth, tooth substances (enamel and dentine) are thickest at the places where wear commonly occurred, namely, on the chewing surfaces and the proximal surfaces. An interesting point in this connection is that first and second deciduous molars, upper and lower, jointly have a larger mesiodistal diameter than the first and second premolars which replace them. If this were not so, the interproximal attrition of the deciduous molars would

leave insufficient space for the two premolars. This shows how attrition is an important and essential part of the whole process of dentition development.

Further evidence that the evolutionary development of the forms, sizes, and shapes of the teeth is inextricably interwoven with and influenced by attrition or, one might say, by adaptation to resist attrition, may be deduced by comparing the long axis lengths of the crowns of different teeth. For what other reason than to resist a longer time (six years) of exposure to attrition is the occluso-cervical length of the crown of the first permanent molar greater than the corresponding length of the second permanent molar? Also, why is this particular measurement even less in the third permanent molar? Obviously, so that the earlier erupting teeth will not be worn out before the later erupting teeth. For the same reason the second premolar is occlusocervically smaller than the first premolar. It is likewise found that the length of the crowns of the incisors, both upper and lower, are greater for the earlier erupting ones (centrals) than for the laterals. It is regarded by the writer to be a rule that the greater length of time of exposure to attrition (i.e., relatively earlier time of eruption) evolutionarily determines relatively greater long axis crown length of the unworn tooth more than any other influence. The canines are unique in that they, erupting later, have relatively greater crown lengths than their neighbors. But this is seen not to be contradictory to the above rule when it is borne in mind that their rate of continual eruption is of necessity faster than in other teeth because, first, they have a greater distance to erupt before reaching occlusion, and second, their corner position in the arches exposes them to more qualitative and quantitative function and therefore more occlusal attrition than their neighbors. Does not this finding strengthen the view that it is absurd still to regard the textbook normal occlusion (with unworn teeth) as really normal? Also, the process of secondary dentine deposition evolved to prevent pulp exposure by tooth wear.

Just as important as the above in preventing our early ancestors' teeth from becoming worn away to gum level, and therefore useless, was the process of continual eruption of the teeth throughout life.

Although continuous tooth eruption, like continuous hair growth, is hereditary, the rate and extent of it may be increased by environmental influences. For example, if a tooth is lost, its antagonist is the opposite jaw, having no occlusal opposition, overerupts. In some of these cases overeruption is so extensive that the soft tissue detachment from the tooth may extend rootward as far as and even beyond the bifurcation of the roots of molars. In these cases interradicular abscesses form. Another example of overeruption is the lower incisors of Class II, Division 1 malocclusion where the lower incisors do not occlude with the uppers but occlude with the palate. Also, in the mouths of "light" chewers, all of the teeth overerupt through insufficient occlusal pressure so that pyorrhea develops earlier in life and gets worse than in the mouths of vigorous hard chewers. In primitive races with tooth attrition, in whom chewing is hard and vigorous, this speeded-up tooth eruption is not found; nevertheless, tooth eruption continues rootward until shedding of the teeth, if the individual lives long enough.

Now that the teeth of modern civilized man do not wear away, this process of continual tooth eruption (which we still inherit from our ancestors) is of the utmost importance from the standpoint of the cause of pyorrhea, one of the worst diseases of civilization.

We still inherit this continual tooth eruption, so that, as we get older, the place where the chewing is done becomes further and further distant from the level of the attachment of the soft tissues to the teeth.

At the same time, the free margin of the gum keeps up to about the same distance away from the chewing surface of the tooth throughout life. The result is that the gingival trough becomes deeper and deeper with increase in age. Therefore the tooth gets a deeper and deeper collar of gum around it, so that pyorrhea becomes worse as we get older. The gum trough gets deeper with age because we now have such soft food that it does not wear the free gum margin down as we chew.

Bacteria, which are commonly present in the mouth, enter the trough and establish themselves and breed on the soft tissues in the gum trough, causing infection and ulceration. This bacterial invasion is very harmful to the general bodily health and commences as soon as we are old enough for the gingival trough to be deep enough for germ retention and protection.

Germs will always breed anywhere in the soft tissues of the body where there is a deep uncleanable trough or a hole open to the body surface which either is not covered by ciliated epithelium or where friction or motion is not caused directly or indirectly by muscular action.

In order to make it more clear why the free gum margin stays at the same level on the tooth while the level of its attachment to the tooth recedes, we will now consider some of the inherited characteristics of gum. In our primitive ancestors, because of the harder and greater amount of chewing which was necessary owing to the nature of the food, the gum tissue was subject to much friction which wore away its surface.

In order to replace this surface loss, the gums evolved the hereditary power of withstanding wear. This resistance to wear and tear took place in two ways; first, by the deposition of keratin (a hard horny substance) in response to friction, and second, by growth of new gum tissue in its deeper layers to replace surface loss. If our ancestors could not have resisted and replaced frictional loss of gum tissue, they would not have survived to be our ancestors.

Our gums, in evolving in our ancestors to withstand much friction, now possess hereditary characteristics which make them still dependent (in us) upon friction for the maintenance of gum health. In the absence of friction, our gums keep growing up to replace loss which does not occur. Therefore, the gums overgrow and form deep collars or troughs around our teeth.

Also, in the absence of friction, they do not harden. This unhardened and embryo-like gum tissue with its soft outer epithelium cannot resist the attentions of bacteria in the gingival trough.

The most important place from the standpoint of pyorrhea is the interproximal space. As the gum attachment recedes throughout life, this triangular-shaped space (see Fig. 1) with its apex at the contact point and its base at the level of the epithelial attachment becomes larger and larger throughout life in civilized man. The interproximal gum is protected from friction by the proximal surfaces of the teeth right up to the contact point much more efficiently than the gum is protected on the labial, buccal, and lingual sides of the teeth. Owing to this protection, the interproximal gum heaps up and grows higher, thereby making a deeper gingival trough than elsewhere around the teeth. Therefore, the germs here have an even better and deeper trough to breed in than elsewhere around the teeth. Consequently pyorrhea is more pronounced interproximally than elsewhere.

Now let us consider how different from that of civilized man is the gingival trough in primitive man with its freedom from pyorrhea.

In contrast to the continually deepening gingival trough on the labial, buccal, and lingual regions of the teeth in civilized man, these regions in primitive man did not become deeper and deeper throughout life. They remained shallow throughout life and therefore remained free from pyorrhea. Primitive man's food caused wear of the teeth to take place at about the same rate as and sometimes faster than the hereditary rate of detachment of the soft tissues from the teeth. Continual occlusal wear of the teeth kept the distance from level of gum attachment always close to the occlusal surfaces of the teeth. Because of this constantly short distance throughout life between the occlusal surfaces and the level of gum attachment to the teeth, the gums received massage or friction from the food which was chewed as this food slid over the edges of the teeth and wore the free gum margins down. Therefore, the gingival troughs remained too shallow for germs to gain a footing owing to the wearing away and hardening of the free gum margins. Therefore, pyorrhea could not develop in primitive man on the cheek and tongue sides of the teeth.

More than just occlusal attrition accounted for the absence of pyorrhea in primitive man. If interproximal attrition had not occurred, the previously mentioned triangular-shaped interproximal space would have become larger and larger throughout life as the teeth continually erupt, as it does in civilized man.

As continual interproximal attrition proceeded, the teeth moved together and maintained contact. Therefore, the gingival edges of the enlarging contact surfaces, i.e., the edges nearest the roots of the wearing contact surfaces of the teeth, receded further and further gingivally. Thus, the interproximal triangular space did not enlarge as it does in civilized man. Therefore, the interproximal gingival trough remained so shallow throughout life that it could not harbor pyorrhea germs and primitive man remained free from pyorrhea.

INFECTION OF IMPACTED THIRD MOLARS

It seems to the writer that the proneness to infection of impacted third molars is due to the continuous hereditary detachment of the soft tissues from the teeth. In view of the seriousness of this infection it seems appropriate to refer here to the part played by the continuous process of periodontal detachment in producing it.

When an impacted third molar is in contact with or very close to the second molar, and lies below or rootward to the level of detachment of the soft tissues of the second molar, there is no infection around the crown of the third molar. This is because it has no opening to the oral cavity with its germ-laden saliva.

Later, however, as the soft tissue attachment around the second molar recedes rootward, it eventually comes to and passes below the level of the impacted third molar.

While this soft tissue detachment of the second molar takes place, there is, of course, a similar hereditary soft tissue detachment from the crown of the impacted third molar.

Therefore, the crown of the third molar down to the level of its detachment, although covered with detached soft tissues and perhaps even wholly or partially with bone, is in free communication with (that is, open to) the mouth cavity.

The germ-laden saliva is therefore able to seep through this opening into the potential space around the crown of the impacted third molar and to form a pericoronal abscess.

In view of the above-mentioned opening into the oral cavity being due to continuous tooth eruption, and in order to infer its etiology, one might be tempted to call this infection a confined or "empyemic" pyorrhea of the impacted third molar.

The mode of development of the opening into the mouth seems to explain why lower third molars, which may be lying horizontally and also very deep or low near the ends of the roots of the second molar, remain free from infection and pain until late in life or throughout life. However, if these deeply impacted third molars become infected, it is severe owing to the greater amount of crown of the third molar which is detached from its investing soft tissues.

On the other hand, it also seems to explain why an impacted lower third molar, in contact with the second molar higher up on the distal root near the neck of the second molar, very soon becomes infected.

It also seems to explain those cases of unerupted teeth having caries which are claimed to support other than the accepted theory of caries etiology. But such teeth on careful examination are found to be in direct communication with the oral cavity and are in this sense erupted.

Perhaps this finding may help to indicate (if x-rays showing the soft tissues can be taken) the most favorable time to extract impacted third molars or whether to leave them alone.

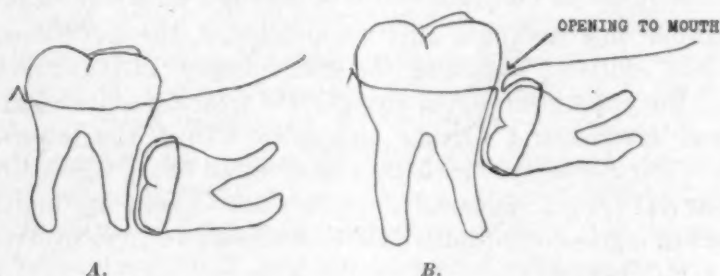


Fig. 2.—Diagrams to show the part played by the hereditary process of continual detachment of the soft tissues investing the teeth in the production of bacterial infection of impacted third molars. The onset of the infection of fully impacted third molars is not due to the further moving up toward occlusion of the impacted tooth but to the moving down or detachment of the soft tissues investing the second and third molars.

A shows position of impacted third molar free from infection and pain because the potential space, around the crown and above the soft tissue detachment from the crown, is not open to the mouth. A third molar impacted as deeply as this would remain free from infection for many years because the receding of the attachment of the soft tissues of the second molar would take a long time to reach the level of the third molar. If this latter level is ever reached, an opening to the mouth occurs with consequent danger of infection.

B shows position of impacted third molar which can become infected because the potential space, around the crown and above the soft tissue attachment from the crown, is open to the mouth. This opening occurs because and when the soft tissue detachment around the second molar proceeds far enough rootward for the opening to form.

Although primitive man was almost entirely free from decay, it seems that he had no more hereditary or general systemic constitutional immunity to these diseases than modern civilized man. Primitive man also seemed to have had no more protection from these diseases in the physical and chemical properties of his saliva. It appears also that his food contained no extra chemical substances such as calcium, or vitamins which we lack, to account for his dental health. With the probable exception of the eskimo, he ate carbohydrates. The physical properties alone, hardness, coarseness, fibrousness, and grittiness seem to account for his immunity. His occlusion being, on the average, hereditarily much better than ours accounts no doubt to some extent for his superior dental health.

Primitive man developed decay and pyorrhea when the above-mentioned physical properties of his food were unable to act mechanically as preventives. For example: in old age, if pulp exposure and death occurred, decay developed

in the pulp chamber because the chamber was too large and inaccessible to be cleansed by the food so that carbohydrates remained to form acids by fermentation. The incidence of decay, although very low, is largely due to this senile pulp exposure by attrition. A native skull in the South Australian museum shows a spear injury several years before death. On the injured side where mastication was prevented, both decay and pyorrhea to a marked degree occurred, and attrition ceased from the time of injury. Mastication continued on the uninjured left side as indicated by the attrition, and here dental diseases were absent. These examples indicate that the hardness, coarseness, fibrousness, and grittiness of the food, and not its chemical properties (which differ little if at all from our food), account for primitive man's dental health, and lack of these food attributes accounts for our dental disease.

Throughout the world, dental students are taught that normal occlusion comprises the full complement of tooth substance. This is entirely wrong because throughout nearly all of the time that man has been man he has not retained all of his tooth substance but has had worn teeth with flat occlusal surfaces and proximal contact areas (instead of contact points) and an edge-to-edge incisor bite.

We are fortunate in South Australia in having the world's largest collection of skulls of primitive Stone Age man. With this valuable material at our disposal we have the opportunity to discover much about his dentition for the benefit of dentistry not only here but in other parts of the world.

Only during the relatively infinitesimally short time since we have been civilized and have refined our food have we had an incisor overbite with absence of attrition. All that we have learned about the exact normal positions for correct tooth occlusion or locking is only true for the short time* just after tooth eruption of, first, the deciduous teeth and, second, the so-called permanent teeth. Only for these two short times after tooth eruption did the dentition, for most of the time since man has been man, look at all like a present-day textbook "normal occlusion." This textbook normal occlusion is untrue for the dentition for most of the life of an individual, and when a dentition remains in this youthful undeveloped stage of occlusion, it soon acquires the diseases of decay and pyorrhea.

Our dentition evolved to its present form in a far more strenuous and a harder environment than it finds itself now in civilized man. The environmental stimulus of our soft food is insufficient to bring about the development of the dentition to its full adult stage.

With the assuming of the edge-to-edge incisor bite from the overbite stage of adolescence, which Dr. Campbell first described, primitive man's lower teeth moved forward relative to the upper teeth so that all teeth in the lower jaw gradually assumed an occlusion with the upper teeth further forward than the cusp locking which is regarded as normal for adult man.

The lower first permanent molar in primitive man in adulthood (flat, worn occlusal surfaces with dentine exposed) occludes in a Class III (Angle) malocclusion with all the other buccal teeth correspondingly forward, and the worn incisors occlude edge to edge.

Measurements were taken by the writer of the sum total mesiodistal widths of the teeth right around the dental arch from the distal surfaces of the second molars of each side in Australian aboriginal mandibles just prior to the eruption of the third molars. Mesiodistal widths of hundreds of loose unworn Australian aboriginal lower teeth which either had only partly erupted or had fallen out

*Textbook normal occlusion is not quite true at any stage in primitive man, because as soon as any tooth erupted, attrition started.

of young dried mandibles in the collection were also measured. The difference between the means (averages) obtained from these two sets of measurements showed that (just prior to the eruption of the third molars) the length of the lower dental arch is reduced by interproximal attrition by just over 14 mm., because, as interproximal wear takes place, the teeth maintain contact by coming closer together.

In the ordinary adult primitive Australian aboriginal mandible, with teeth in regular normal alignment, the teeth, from third molar to third molar, occupy the whole of the tooth-bearing part of the mandible. This means that if there had been no reduction, by interproximal attrition, in the length of the dental arch, the teeth would have been crowded (i.e., imbricated) and not in regular alignment and occlusion, or the third molars would have been impacted or the lower incisors would have been pushed forward off the ridge with the labial surfaces of their roots somewhat exposed. In some civilized Australian aboriginals who, of course, have no attrition of the teeth, the upper and lower incisors, as indicated by the denudation of gum from the labial surfaces of the roots, have been pushed off the ridge. In other words, there is double (inferior and superior) protrusion because the hereditary sizes of the tooth-bearing parts of the jaws are not large enough to hold all the teeth in the absence of attrition.

It is normal (a) to inherit too much tooth substance, and (b) to have attrition. (a) + (b) equals normal occlusion. This is also true to my knowledge for Neanderthal man, Mousterian man, *Sinanthropus Pekinensis*. It is also true for primitive Anglo-Saxons as shown by the photographs of sixth century Saxon skulls found at Bidford-on-Avon and published by Miss Corisande Smyth in an article in the *INTERNATIONAL JOURNAL OF ORTHODONTIA* for January, 1935. One important reason why there are, relatively, so few modern civilized people today with teeth in so-called, textbook, normal occlusion, is because of lack of interproximal attrition. Only those of us who inherit what would be smaller teeth than could be accommodated in normal occlusion if we lived as Stone Age man have normal occlusion.

Those of us who inherit teeth of a size which would completely fill the tooth-bearing parts of the jaws if we lived primitively and therefore had attrition now have some form of tooth crowding.

The significance of the above from an orthodontic standpoint is that to attempt orthodontic treatment without tooth removal, where indicated, is biologically incorrect. Of course, there are some modern as well as some Stone Age men who had teeth so small that they were spaced. However, there are more, both modern and primitive, with overlapping (imbrication) because of inherited small jaws and large teeth. One often wonders why so many cases formerly treated without extraction remained in positions which would pass as normal occlusion.

Observations of treated cases without extraction here and in the United States leave no doubt that relapse is inevitable where tooth size is too great for jaw size. Idealism based on a wrong philosophy which is based on conservative wishful thinking and not on scientific investigation accounts for most orthodontists' still refusing to extract teeth.

Treatment without extraction was responsible for the impaction of many third molars. The use of occipital anchorage on both jaws to stop the anteriors coming forward when crowded teeth were treated by expansion of the arches caused impaction of third molars. Lack of attrition causes mild crowding compared with the crowding due to the inheritance of still larger teeth, i.e., ab-

normally large teeth and small jaws. That jaw size is due almost entirely to inheritance is well shown in the collection of Sir George Northcroft; his collection shows specimens of congenitally edentulous jaws as large as any with teeth. Again, if masticatory function determines jaw size, then Stone Age and earlier man should all have had spaces between their teeth. The truth is that natural selection (survival value) is responsible for maintaining that degree of harmony between tooth and jaw size which produces a good efficient occlusion.

Nearly all specialists in orthodontics still adhere to the practice of preserving the full complement of thirty-two teeth. This is a result of the invention of the modern type of fixed appliances now used by all orthodontists and which makes possible the movement of all the teeth into alignment. Owing to the mechanical efficiency of these appliances, orthodontists, proud of their skill in being able to move teeth so well, felt justified in accepting the teaching that heredity played no part in the etiology of malocclusion but that environmental influences were entirely responsible. This latter view dies hard. In several countries and, at last, in the United States a small number of orthodontists practice tooth removal (the four first premolars chiefly) with treatment by modern fixed appliances. Their success has been greater than is possible by other means. They have been and still are assailed and adversely criticized by the die-hard nonextractors. So far the only answer of the extractors is the practical one—results which are esthetically better and which do not relapse as do a large proportion of cases treated without extraction. This practical answer should be adequate but it has not proved to be because it has not gained converts fast enough. As the nonextractors are unable to deny the greater success of the modern extractors, they rely on theoretical argument to oppose the extractors. It therefore behooves the extractors to show the nonextractors that the theory of etiology is on the side of the extractors.

This should be borne in mind by those idealistic orthodontists who anachronistically still demand the retention of the thirty-two teeth when treating malocclusion.

At present we have no better remedy for decay than frictionally cleaning the teeth and filling them. We have no better remedy for the prevention of pyorrhea than brushing the gums at the margins of the teeth and gums every day and, more important still, daily massage with thin enough toothpicks (thanks to Dr. Fish) of both interproximal gum troughs in each interproximal space.

Gingivectomy, or packing the troughs with zinc oxide and eugenol cement, when necessary in well-advanced pyorrhea, and paraffin packing, are not cures for pyorrhea but are sometimes necessary preparations to make possible the real treatment of pyorrhea which is the proper daily use of toothpicks.

As long as the toothbrush is properly used and the toothpicks are rubbed backwards and forwards daily right to the bottoms of all interproximal troughs, pyorrhea will be absent. On the other hand, if the patient gives up the rubbing because the dentist does not keep up the education campaign and supervision, the pyorrhea will come back.

At this stage a word of warning about the recognition of pyorrhea may be to our advantage. In those patients who brush their gums regularly, the gums on the cheek and lip sides of the teeth are often quite healthy and free of pyorrhea so that the patient is passed as being free from pyorrhea when further examination reveals extensive pyorrhea in the deep gingival troughs of the interproximal spaces where the toothbrush cannot penetrate.

Pyorrhea is more easily recognized in the deep gingival troughs completely surrounding the teeth of patients who do not brush their gums.

Patients who work hard and long with the toothpick completely remove the V-shaped interproximal dental papilla so that there is after some months a flat plane instead of a mountain of gum between neighboring teeth.

The dentist receives little money for the long time which is necessary to teach and demonstrate gum hygiene. Lazy and skeptical patients require a long time to educate. Therefore, will many dentists devote the time which is necessary to free their patients from pyorrhea and tooth loss?

Although the remuneration is small, the benefit to our patients is much greater than much of the expensive work we do. The public should be taught proper interdental and toothbrush massage by someone else if we dentists will not, or cannot, spare the time.

Now to refer again to malocclusion of the teeth and associated jaw deformities.

The commonest form of malocclusion is due to crowding of the teeth. Tooth crowding and resultant wrong occlusion of the teeth occurs through the inheritance of large teeth from one ancestor and small jaws from another ancestor. Teeth and jaws are separately inherited. It has been proved by statistics from measurements in both primitive and civilized man that the average size of the teeth is larger in that group who have crowding than for those who have even teeth in normal alignment and occlusion. On the average, those who have spaces between their teeth have smaller teeth than the two above-mentioned groups. On the average, the jaws of those with crowding are smaller than those with normal occlusion. Large teeth are mendelian dominants; so are large jaws. Small teeth are mendelian recessives; so are small jaws.

Another common type of jaw and occlusal deformity is the so-called adenoid facies in which the lower jaw and teeth are too far back compared with the upper jaw. This condition is inherited as a mendelian dominant and may sometimes be accentuated by lip-biting or thumb-sucking.

The third and less common condition is protrusion of the lower jaw and teeth which is also inherited as a mendelian dominant. Orthodontic treatment is now carried out by banding of the individual teeth; in other words, by fixed appliances to give adequate anchorage for tooth movement by labial arches in conjunction with extraction, where indicated in the light of our present knowledge of the causes of malocclusion. Photographs in orthodontic journals of cases treated without extraction do not show the full complement of teeth in occlusion because the third molars have not erupted.

All types of malocclusion and jaw deformities which we now have were present in primitive man but were more rare. To have a good dentition was more important to primitive man than to us because primitive man's survival depended more upon being able to chew well than it does with us. Therefore, those primitive individuals with occlusal deformities had less chance of survival and of transmitting deformities to their offspring than individuals with correct jaw shapes and occlusion.

Class II, Division 2 had a very low survival value in primitive man because attrition early caused pulp exposure of lower incisors labially and upper incisors lingually.

Because we prepare our food for digestion outside of our mouths more than did our primitive uncivilized ancestors, almost all of us can survive and breed regardless of our mouth conditions. Our hands and brains are usurping the functions of our jaws.

Premature loss of deciduous teeth does not cause crowding of the permanent teeth. That it does is still taught because it is not yet sufficiently well known that it has been discovered by statistical research that tooth and jaw size are separately inherited. It is still widely believed and accepted (without any knowledge whether adequate investigations have been undertaken to prove or disprove the belief) that premature loss of deciduous teeth causes crowding of the permanent teeth. The following refutes this belief.

If the hereditary total size of the tooth-bearing part of the jaw is large enough to hold all of the teeth in regular alignment, premature loss of deciduous teeth will not cause loss of space and crowding of the second teeth.

On the other hand, if the hereditary jaw size is insufficient to hold all of the permanent teeth in regular alignment, premature loss of deciduous teeth allows the remaining deciduous teeth to find more space and to drift to the place where the tooth was lost, so that, although crowding was inevitable in such a jaw regardless of tooth loss, all that happens is that the site of crowding is changed from one part of the mouth to another part.

Take just one example. Consider a mouth in which the jaws are too small and tooth crowding would therefore be inevitable, and in which a deciduous first lower molar is lost too soon. In this case the lower permanent incisors would be crowded and overlapping if no deciduous tooth had been lost, but, owing to the loss, these permanent incisors then have enough space to erupt in regular alignment because the deciduous canine will drift back to the vacancy left by the lost molar. Therefore, the space between the two deciduous canines will be big enough for the four permanent incisors to take up regular alignment.

However, the later erupting permanent canine and first premolar have been cheated of their space and will be unable to erupt in regular alignment.

All that has happened in this case is that the site of crowding has been transferred from the incisor region to the canine and premolar region.

Orthodontic treatment has the same object as all other branches of dentistry, namely, the gaining and maintaining of correct and healthy occlusion of the teeth.

Neglect of orthodontic treatment when it is required leaves the patient with an unsightly appearance which reacts detrimentally on the patient as well as on other people. This neglect also increases tooth decay and pyorrhea because the stagnation areas are less easily cleansed by food or the brush in cases of malocclusion.

I wonder if someone some day will produce a food which is very pleasant to eat and which at the same time will cause wear of gums and teeth and massage of the gums, thus eliminating decay and pyorrhea.

For several reasons the dental profession is unable to give the service to the community which it needs to acquire and maintain dental health. Further research is necessary to find a diet or some other means of successfully and simply cleaning and rubbing the gums and the teeth and then to see that vested interests in the food and other industries do not prevent its introduction.

There are now less than one-tenth enough dentists for the population and, also, many people cannot afford to have everything done that they need.

A vast amount more is required to make and to keep the population dentally healthy. What is required is for the community as a whole to spend more in an organized way on correct dental education and then make it possible for everyone in the community to have all of the dental treatment that is required. Until this is all done, none of us should be satisfied. Unless the dental pro-

fession gives better service than it is now giving and has given to all sections of the community, the community for its own protection will take it into its own hands without consulting us to see that it receives adequate dental treatment.

To sum up: in this paper I have endeavored to stress the point that every branch of dentistry contributes to the same object, namely, the promotion and maintenance of a healthy and normal occlusion of the teeth, and that the neglect of any one branch will result in failure in the other branches however well they are attended to. Having failed, we then have to fall back on prosthesis, our last resort. I have also endeavored to show some of the dental differences between primitive man and civilized man: that the diet of primitive man by its motion and agitation and the consequent occlusal and interproximal attrition maintained health, whereas modern civilized man's diet, by allowing dental stasis and stagnation and lack of tooth and gum wear, produced the bacterial diseases of pyorrhea and tooth decay and tolerated the hereditary increase of malocclusion and jaw deformities. Tooth extraction is essential in orthodontic treatment. Primitive man maintained a healthy efficient dental apparatus without conscious effort.

On the other hand, we can do this only by the conscious effort of the promotion, advancement, and practice of dental science.

Much still remains and is urgently required to be done before the community will be made and kept dentally healthy and sound. Propaganda is necessary to teach that prevention of dental diseases is more important than treatment of the diseases. Those needing most education and treatment can least afford it. Because we cannot have healthy minds without healthy bodies, free dental education and treatment are as necessary as free school education. This would pay high dividends in work and efficiency.

INDICATIONS FOR THE OCCLUSAL GUIDE PLANE

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IT IS indeed a pleasure to be present at this magnificent meeting, and I deem it a special privilege to be here before this Orthodontic Section today.

My presentation will be a discussion and demonstration of the occlusal guide plane. In my discussion here, my remarks fall into three groups: First, I shall attempt to bring to you the philosophy of the occlusal guide plane. Second, I shall clarify its indications and its limitations. And third, resulting from the other two, I shall make understandable its proper purpose and use.

In demonstrations, to be given later, I shall show models of cases treated with the occlusal guide plane and shall exhibit the actual appliances used in the treatment of some of these cases. I shall also demonstrate the step-by-step construction of the occlusal guide plane, and shall then attempt to answer any questions you may care to ask. I venture to hope that our meeting together to examine thus both the theory and the practice of the occlusal guide plane will be a profitable professional experience for us all.

Read before Graduates and Orthodontic Group, University of Michigan, May, 1945.
Read before The Orthodontic Club of Toronto, May, 1945.

In the very beginning, let me make one point clear. The occlusal guide plane must not be confused with what is commonly called in orthodontic literature a "bite plane" or a "bite guide." These appliances are usually of the removable type and are defined in our dental dictionaries as "some form of guide or plate which the mandibular incisors forcefully engage in closure." They are usually restricted to secondary treatment or retention. Let us accept the fact, in preliminary definition, that the occlusal guide plane is a much more specific appliance. It is a primary treatment appliance. The mandibular incisors do not forcefully engage it, but instead are guided by it. It is a fixed removable mechanical device, having an established inclined plane, which, when in use, causes a change in the occlusal relation of the maxillary and mandibular teeth and permits their individual movement into a normal position.

In accepting the name "occlusal guide plane," we have by title that which immediately designates a device which has a definite relation and purpose in treatment. That is, the word "occlusal" immediately brings to mind the occlusal surface of the teeth; the word "guide" causes us to think of the device as related to the teeth so that it will have a guiding effect when in use; and the word "plane" we associate with a surface, inclined or flat—in this instance inclined.

The fact that it is a fixed-removable appliance is a decided advantage over any merely removable type of appliance. We need not dwell on the fact that it is a mechanical device; all present know this to be true. We know it has a plane—not just any kind of plane, but one constructed with precision and definitely established to comply with the requirements of each individual case. This inclined plane is made of wire by flagree interlacing and is constructed on a basic maxillary lingual arch, as will be demonstrated later. Thus we see that the occlusal guide plane is not in itself a separate individual appliance, but rather is a positive addition to the labiolingual technique. In its true sense, it is an auxiliary attachment to the maxillary lingual arch.

In constructing this plane, we create it so that the mandibular teeth will bear a definite relation to it and will be placed in a definite predetermined relation with the maxillary teeth. We can change the incisal relation as well as the occlusal relation of the upper and lower teeth, and by so doing allow Nature, either of her own accord or in conjunction with movement by mechanical means through components attached to the lingual and labial appliances, to move the individual teeth to their respective normal positions. There is, of course, variance in the change of the occlusal and incisal relation to meet the requirements of each individual case.

In a study of the occlusal guide plane, there are two definite factors to be considered: the angle and the depth. The angle at which the inclined plane is constructed determines the anterior-posterior change of occlusal relation which will be produced. The depth of the plane determines the vertical dimensional change which will result. In other words, if anterior positioning of the mandible is indicated, the angle of the plane is constructed so as to cause the mandible to assume the desired position when the teeth are brought together. If vertical dimension is needed, as it usually will be, the constructed depth of the plane will definitely establish the desired vertical dimension. If it is a neutroclusion case, and only vertical dimension is needed, the angle of the plane will be set so as not to cause any anterior positioning of the mandible, and the depth of the plane, operating alone, will give the desired vertical dimension.

Perhaps by now each one of us can visualize why each and every occlusal guide plane must be precisionally constructed for the individual case where it is

indicated. Perhaps also, we all can now visualize the type of cases where its use is indicated.

Like any appliance, there are very definite things that the occlusal guide plane will accomplish. Thus there are definite indications for its use. Likewise, there are many things it will not accomplish and was never intended to accomplish. Thus, there are contraindications for its use. Let us not forget that one of the secrets of the successful use of any appliance is a thorough understanding of when to employ it, and when not to employ it.

Now, for what cases is the plane indicated? Since the chief purpose of the occlusal guide plane is to aid in the establishing of a correct anterior-posterior relation of the teeth and arches and the occlusal and incisal planes, one of the most satisfactory uses will be found in the treatment of Class II, Division 1 cases. As you will recall, this type of case presents a bilateral distal relation of the lower arch, protruding maxillary anterior teeth, narrow maxillary arch, undersized mandible, abnormal muscular pressure, abnormal atmospheric pressure, and mouth-breathing. It was the desire for an appliance to treat more successfully this type of malocclusion that led me to develop the occlusal guide plane.

I formerly corrected this Class II, Division 1 type of malocclusion with maxillary and mandibular labial and lingual arches, supplemented by intermaxillary elastics. Some of my cases were successful; yes, yet I found objections to this procedure. The treatment period was too long. The success of the treatment was not definitely in my hands, but depended too greatly on whether or not the patient wore the elastics. Some patients would wear them, and we got results, while others would not wear them, and of course our progress was not satisfactory.

Then there were the cases with very deep cusps that would not yield satisfactorily to the intermaxillary elastics alone. There were also the individuals with unusually developed facial muscles that prevented the desired movement by elastics alone. There was also the fact that in many cases of this classification, even if the elastics did obtain satisfactory anterior movement of the mandible and lingual movement of the maxillary anteriors, they did not also develop sufficient vertical dimension; consequently there was excessive pressure exerted by the mandibular incisors on the lingual of the maxillary incisors, and relapses were inevitable.

I wanted an appliance for the treatment of this type of case that would combat successfully all of these complications. In the occlusal guide plane, I found such an appliance. With great pleasure I share with you my solution of the problems.

With this appliance, the success of treatment is definitely in my hands. I use intermaxillary elastics, it is true, but the anterior positioning of the mandible does not depend on them. They are principally to move the maxillary incisors lingually. The mandible is definitely set forward a specific amount by the carefully calculated and constructed angle of the guide plane. The patient cannot occlude distal to the guide plane, so this is a positive movement. Deep cuspal interference is overcome; abnormal muscle resistance is overcome; and the exact desired vertical dimension is established.

There are some extreme distocclusion cases where the guide plane cannot be placed in its ultimate position because the patient could bite behind it. In these cases, the plane is constructed so that the bite is not advanced all of the way at one time, but it is moved forward in several stages. This will be discussed further, when we consider construction.

In some few cases of malocclusion, there is an indication for anterior positioning of the mandible en masse, without the need of lateral or vertical movement of the posterior teeth. These cases are ideal for treatment by the occlusal guide plane. The angle of the guide plane is constructed so as to guide the mandible to the desired position, and the depth is constructed so as not to cause any vertical development. The use of intermaxillary elastics is optional, but I usually use them to lessen the strain on the muscles, created by the sudden change of the occlusal relation, or to help obtain any lingual movement of the maxillary anteriors that is indicated.

So I repeat that for Class II, Division 1 cases, the occlusal guide plane is ideal. Your treatment time will be greatly reduced, and the adjustment periods may be placed further apart; but what is most important, your results will be more satisfactory and permanent.

Another definite indication for this appliance is Class II, Division 2 cases. As you recall, such cases present the problem of bilateral distal relation of the mandibular arch; retruding and bunched maxillary anterior teeth; maxillary arch nearly normal in width; normal-sized chin; normal-sized mandible; normal muscular pressure; normal atmospheric pressure; and normal breathing.

Since the maxillary anteriors are often retruded, it is sometimes necessary to tip these teeth forward before placing the guide plane. If the retrusion is not too severe, however, extensions from the guide plane along the lingual surface of the maxillary incisors will move these teeth to a normal position while the guide plane is normally positioning the mandible. If there are rotated or crowded anteriors, these teeth can be normally positioned with greater ease when a guide plane is used, because they are relieved of the trauma of the opposing incisors.

Treatment of this type of case is almost identical to that of Class II, Division 1 cases; but since in this type of case we find a normal-sized mandible, treatment time can be even less than in Division 1 cases where mandibular development is nearly always necessary.

The occlusal guide plane may also, in the third place, be very successfully used in the correction of cases falling into the subdivision of Divisions 1 and 2 of Class II. The condition here is a unilateral distoclusion, having the same characteristics as the respective divisions.

In these cases, the appliance employed is very similar to that used in the bilateral cases, except that it is constructed so as to cause a shift on the side that is distal, while the other side is maintained in the normal position.

Where the malposition is extreme, it is sometimes necessary to use more than one guide plane, and to use them in a series, to cause the change anteriorly by degrees.

Some dentists may question the use of the appliance in treating cases of this type, in that their opinion may be that it is impossible to shift one side and not the other equally. In basic fact, this is true, for the mandible does move en masse; but in such cases the shift compensates, for both sides are not moved in like direction, and it is possible to change the position of one side, without disrelating a normal area. This is, of course, applicable only to cases where the unilateral distoclusion is due to a malposition of the mandible, and not to a unilateral mesial drift of a maxillary posterior segment.

It falls to the field of diagnosis to determine when there exists a true distoclusion or when there is a mesial drift of the maxillary posteriors; so we will not go into that. However, we do know that, in many cases, there is an indica-

tion for distal movement of the maxillary posteriors and also an indication for both distal movement of the maxillary posteriors and anterior positioning of the mandible occurring in the same case. Either of these can be ideally accomplished with the assistance of the guide plane.

Where only distal movement of the maxillary incisors is needed, a U-shaped bend is made in the maxillary lingual arch just anterior to the vertical half-round post. This can be opened at each adjustment, as the molar moves distally. The principal actuating force would be coil springs on the labial arch. The advantage of the guide plane here is to establish sufficient vertical dimension to relieve cuspal interference. This is especially beneficial if there is an extreme mesial tipping of the first molars, as is so often seen when second primary molars have been lost prematurely. Proper adjustment of the U bend in the lingual arch is an ideal way to straighten up the mesially tipped molar. If anterior positioning of the mandible is indicated as well as distal body movement or distal tipping of the maxillary posteriors, the guide plane is constructed accordingly.

There are further definite indications for the use of the occlusal guide plane, other than the Class II or distoclusion cases. Class I or neutroclusion cases with closed bites can naturally be corrected.

I know that it is doubted by some men who use bite planes that we can actually get an elongation of the posterior teeth. It is their opinion that there is only a depression of the mandibular anteriors. I am personally convinced that we definitely do get an elongation of the posterior teeth. I say this because I open bites and change an exaggerated mandibular occlusal curve by employing the occlusal guide plane; and this appliance, contrary to the bite plane, does not contact the incisal edges of the mandibular incisors in such a way that it could cause depression of these teeth. Then too, many neutroclusion closed-bite cases can be appreciably opened by the buccal tipping or straightening up of lingually tipped or lingually placed premolars and molars. The presence of a guide plane establishing vertical dimension certainly makes this possible in a shorter length of time and with less trauma.

In some closed-bite cases, there is a definite indication for the depression of the maxillary anteriors, as well as elongation of the posteriors. This can be nicely accomplished by extensions from the guide plane extending down the lingual surface of the maxillary incisors and hooking over the incisal edge. These extensions are shortened as the incisors intrude.

Aside from the freedom allotted for vertical growth of the posterior teeth, the occlusal guide plane will be found most useful in extending vertical growth of erupting premolars, particularly where there is clinical evidence indicating the necessity of changing anterior tooth position. I refer to such position of the lower to the upper anterior teeth wherein the incisal edges of the lower teeth contact either the gingival tissue or the linguogingival surfaces of the upper anterior teeth.

When the appliance is used here, and a correct plane is mechanically established, the erupting premolars will develop vertically to meet this plane. At the same time during this interim of growth change which is taking place in the premolar area, a like change is taking place with reference to the anterior teeth, and their correct position in the line of occlusion is being established.

In constructing the appliance for the treatment of such inequalities, all that must be kept in mind is the establishment by separation of the correct plane to which the teeth will erupt and which, when erupted, will allow the

anterior teeth to assume their correct position. In meeting the requirements to accomplish this end, the appliance, when completed and in position, must not cause any change anteroposteriorly of the posterior teeth.

One other definite indication or use of the guide plane is as an appliance to break the habits of thumb-sucking and tongue-thrusting. You can readily see how the mere presence of this appliance would make the continuance of these habits impossible. If necessary, sharp spurs could be placed at suitable points. However, this is rarely necessary. Most thumb-suckers present a Class II, Division 1 type of malocclusion, as previously discussed. The occlusal guide plane is ideal for the correction of this type of case. So by its use, we are removing the cause, by breaking thumb or tongue habits, at the same time that we are treating the abnormality.

One other positive indication for the occlusal guide plane that I would like to mention is its assistance in changing the axial plane of the maxillary anterior teeth. This change is brought about by its use in conjunction with the labial appliance. It takes place mechanically by use of perpendicular auxiliary springs attached to the labial appliance. Pressure reflected therefrom, to the teeth, causes a change in their position. The occlusal guide plane has so related the lower anterior to the upper anterior teeth as to separate them sufficiently to permit this axial change to be brought about without interference. This change primarily has to do with teeth in slight or pronounced labioversion, wherein the lower teeth contact the lingual surface or linguogingival area in such a way that successful movement would otherwise be prevented.

There are also positive contraindications for the use of the occlusal guide plane. These are any cases of Class III type malocclusion and any case that presents even a tendency to an open bite. There are others; however, I do not believe we need search for them, for if one has, or will acquire, a thorough understanding of when to use it, what it was designed to do, and will do, he will likewise know its limitations and when not to use it.

And now, in conclusion, let me stress again the fact that by no means is the occlusal guide plane to be considered a universal panacea for all malocclusions. It was originated, designed, and perfected to accomplish certain definite objectives. It is my sincere opinion, however, that when it is indicated it will accomplish, or aid in the accomplishment of, the desired results as efficiently as any mechanical appliance that may be used, and it has the following advantages:

1. It changes the bite to normal immediately, in most cases, thus cutting down considerably the length of treatment.

2. In placing the arches in normal relation, they are placed so that normal muscular action is possible from the beginning of treatment. This is most important since in most cases abnormal muscular action is present.

3. It opens the bite for the possible vertical growth in the molar and premolar region so often required and so slowly obtained by other methods.

4. It opens the bite for a more favorable movement of maxillary individual teeth which may be locked in position of malocclusion prior to the placement of the guide plane.

5. It fixes the bite at the normal relation as far as we may determine, rather than a hit-or-miss relation obtainable when using elastics alone.

6. It changes the profile immediately, creates confidence, initiates greater cooperation, as the patient can readily see what is to be the end result. Parents are most favorably impressed.

7. The immediate placement of the guide plane favors normal breathing instead of mouth-breathing, due to the establishment of a normal position of the jaws and lips.

8. It tends to break tongue habits, lip-biting, thumb-sucking, and other harmful habits.

9. Failure, due to lack of cooperation in wearing elastics, is overcome. A patient may wear elastics or leave them off, and the bite remains the same.

10. Other treatment can be carried out simultaneously, as the bite is being changed. It is common practice to expand the upper arch and move the upper anteriors back, and to rotate them, while the guide plane is in position.

11. In the troublesome "dual bite" condition, there is a distinct advantage over elastics, as the patient cannot change from one bite to another.

Of course, in all of the uses of the occlusal guide plane, just as with any appliance, regardless of rules set forth, some degree of common sense and application is necessary. It is not within the province or laws of man to meet in every instance, without variation, the requirements of nature.

1101 MEDICAL ARTS BUILDING

ANOMALY OF UPPER RIGHT CENTRAL INCISOR

CASE REPORT

ADOLPH JUTKOWITZ, B.S., D.D.S.,* NEW YORK, N. Y.

THE case to be presented is of interest because it concerns an anomaly in the formation of the upper right central incisor.

The patient, W. G., a boy 9 years 2 months of age, presented himself for the correction of a malocclusion and because his upper right central incisor was not completely erupted. Figs. 1 and 2 show a photograph of the teeth and casts of the case previous to starting treatment. In fact, when the boy was first seen, only the two opposing corners of the tooth were visible, giving the appearance of two separate teeth erupting. The upper right lateral incisor was erupting to the lingual and it appeared as though it were a supernumerary tooth.

X-rays were taken and it was found (Fig. 3) that the upper right central incisor had a very large crown made up of two parts which appeared fused for most of its length from the incisal to the gingival portions, with two separate roots and two separate pulp chambers and root canals. The upper right permanent lateral incisor and cuspid were present. The upper left permanent central incisor and lateral incisor were in lingual version.

The history revealed nothing which could account for the anomaly. The boy's father seemed to think that a fall which the boy had suffered when he was 2½ or 3 years of age might have been a contributing factor. This is disproved by the fact that the incisal half of the central incisor crown is calcified before that age is reached.

It was decided to first correct the positions of the upper left central and lateral incisors. Bands were placed on the upper first permanent molars with horizontal buccal tubes into which a labial arch, 0.040 inch in diameter, was placed. By the time these teeth were put into their correct positions, the anomalous central incisor had erupted completely.

Since the tooth presented two separate pulp chambers and two separate roots it was decided to separate the two parts of the crown by cutting through the fused position with carborundum disks. The mesial part of the tooth was to be brought mesially and was to occupy

*Assistant Professor, Department of Orthodontics, New York University, College of Dentistry.



Fig. 1.



Fig. 2.

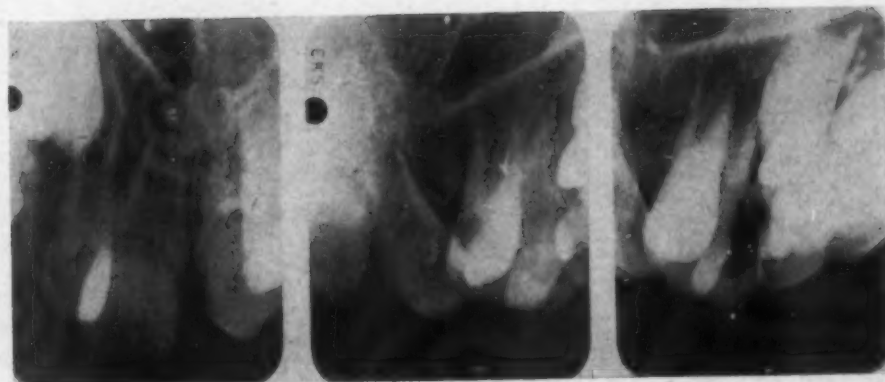


Fig. 3.



Fig. 4.



Fig. 5.

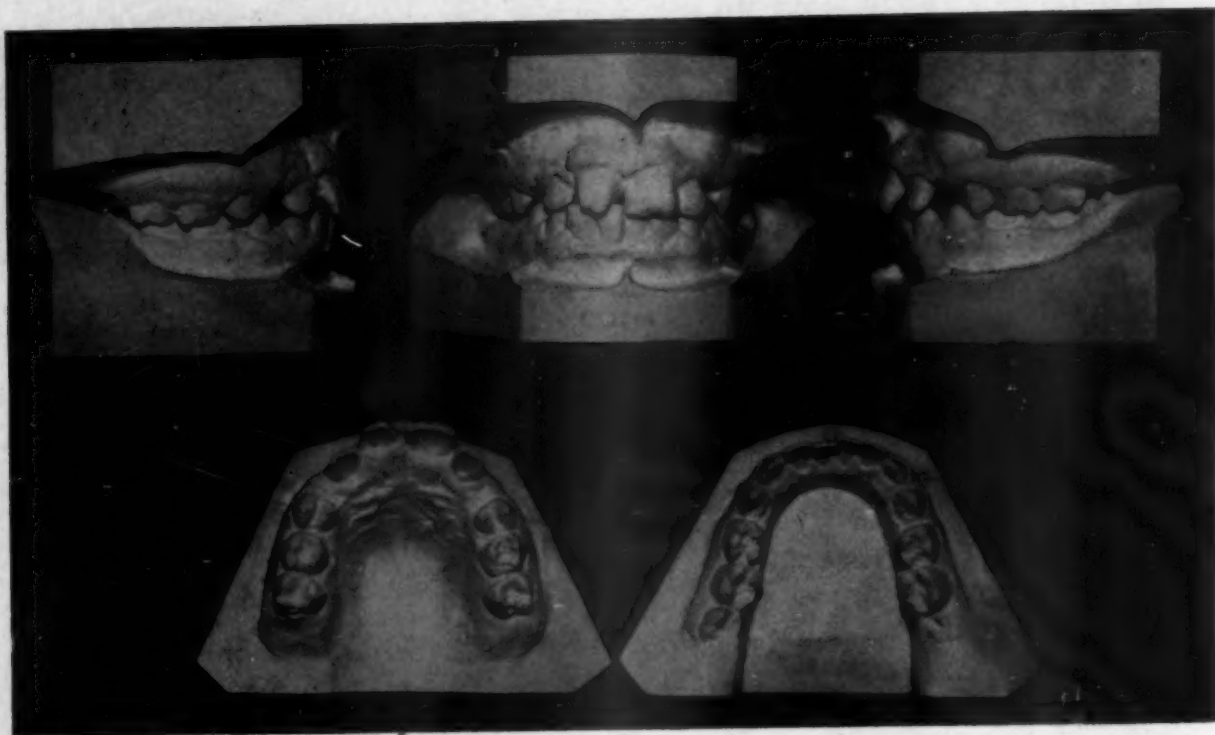


Fig. 6

the position of the right central incisor while the distal portion was to be extracted. Four months after beginning the orthodontic treatment this separation was done. The orthodontic treatment was continued as planned and the upper right lateral incisor was placed in its proper position.

Fig. 4 is a photograph showing the mesial part of the central incisor in its proper position prior to extracting the distal portion.

Fig. 5 is a photograph after the treatment was completed showing the upper lateral incisor in its correct position.

No attempt was made to move the right lateral incisor into position until the distal half of the central incisor was extracted.



Fig. 7.

The mesial portion of the central incisor has maintained its vitality and at a suitable time will have a porcelain jacket crown placed on it to match the opposing tooth.

Fig. 6 shows the casts at completion of treatment, and Fig. 7 shows the x-rays.

The significant facts with regard to this case are: (1) some anomalous tooth forms can be so controlled as to make them, or portions of them, serviceable units of the dental arch; and (2) observation of cases during developmental periods make it possible to resort to relatively simple procedures for the prevention of complicated malocclusions.

I wish to thank Dr. Hemley for his cooperation in planning the treatment for the patient.

Editorial

Orthodontic Concepts

THE circus lady swings and twirls forty feet above the ground and her weight is held only by a thin strip of leather gripped firmly between her teeth. She may dislodge inlays or pull off crowns, but she will not move the teeth in their supporting structures.

The circus act creates a tremendous pressure directed on the teeth, but it requires more than pressure to move teeth. According to our best authority, it requires time for biologic processes to set up a physiologic reaction as a result of delicate energy applied to the teeth.

Every orthodontist soon learns that a slight impulse directed against a tooth in the mouth of a healthy child and carefully maintained for a period of weeks will cause the tooth to move, and that too much of the same energy directed to the tooth or teeth sets up inflammation.

Read much of the orthodontic literature of the past and you are impressed with various concepts. A few years ago one of the best-known plastic surgeons of this epoch made the cryptic observation that the greatest single resistance to orthodontic progress in the past has been an all too obvious architectural and mechanized approach to its problems and that this characteristic has been plainly manifest all the way from the original pioneers of the subject down to the present time. To put it another way, Byron Hughes* makes the observation that orthodontics has been poorly scienced, and contrarily that, on the whole, it has been practiced well."

Plainly what Hughes means, to put it bluntly, is that orthodontics has set up a very good record by the use of clever and painstaking artisanship applied to human tissues. If we are to be tolerant, it must be admitted that the observation is largely true, and no one will contend that orthodontics did not start its career primarily upon a mechanical concept. Even so, what was accomplished with that concept alone seems almost marvelous.

What is the impulse that prompts an orthodontist to remove all appliances from a patient to note the case immediately improve? He cannot tell you exactly, but he will say that many times that kind of treatment works very satisfactorily subsequent to a period of months of active treatment.

If he will explain, he will probably give you some theory about the normal growth urge of tissue having been sharply retarded by too long a period of treatment and mechanical tampering.

Someone of wide experience has said that it takes an experienced operator to know when to remove orthodontic appliances. Whether he or someone else put them on, whether it is this or that kind of an appliance, there comes a time in the treatment of many cases when this simple act is excellent treatment and practice.

This all adds up to the fact that the orthodontist who has not learned to go along and take advantage of the normal attributes and growth impulses,

*Nature's Plan and Orthodontics: AM. J. ORTHODONTICS AND ORAL SURG. 31: 369, 1945.

appliances notwithstanding, still remains to be indoctrinated with one of the most important aids in orthodontic treatment and probably the least used up to now.

Broadbent, LeRoy Johnson, Oppenheim, Howard, Hellman, Becks, and many others have done a great deal to offset much of the thinking born during the period referred to above when the twisting of wire ligatures or the pull of a grass line exerted pressure measured in fractions of pounds on a single tooth.

Mechanical methods of treatment shift and change, like the sands of the seashore; most of them are discarded or changed entirely through the years, but the fundamental urge and basis of tooth movement remains the same and can be utilized in a very practical way by the one who will learn to use mechanical devices as an important aid in treatment, but not as the beginning and the end of treatment.

The oral surgeon knows much about the quick repair and growth of living oral tissue, and orthodontists are becoming more and more conscious of the importance of this attribute in treatment, provided they are able properly to "harness" its motivation. Overgadget-mindedness can be as great a sin as too much wishful thinking in the treatment of malocclusion, and to this many widely experienced operators will attest.

The scientific facts assembled by orthodontic investigators do not attain their greatest value or serve their finest purpose until they are translated and broken down and used in everyday treatment. One of the most important lessons to be gained from these assembled facts translated into the field of daily practice is that it is a fallacy to offset normal growth impulses in oral tissue by too much violent appliance manipulation.

An eminent oral pathologist recently said, "If orthodontists will see to it that nutrition and growth keep pace with their mechanical manipulations, much of their relapse problem will disappear." That does indeed sound reasonable.



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Department of Orthodontic Abstracts and Reviews

Edited by

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A Quantitative Method for the Comparison of Cranio-facial Patterns in Different Individuals: Its Application to a Study of Parents and Offspring: By Wendell L. Wylie, Department of Orthodontia, College of Dentistry, University of Illinois, Chicago, *Am. J. Anat.* **74**: 39-60, January, 1944.

This investigation attempts to provide a quantitative method for comparing the craniofacial patterns of various individuals, a method applicable not only to family studies, but also to comparisons of any individuals of the population of whom cephalometric roentgenograms might be taken. The Bolton technique (Broadbent, 1931) applies such a method to the head and has been described in the literature.

Frontal and lateral cephalometric roentgenograms were taken on the Broadbent-Bolton instrument in the Department of Orthodontia, the University of Illinois, on all the living members of fifteen different families. Thirteen of the families had a living pair of twins of the same sex. No attempt was made to distinguish fraternal from identical twins. Both parents were living in thirteen of the families and were x-rayed; in two families the father was deceased. Other siblings in the families of the twins were included. Sixty-five individuals were x-rayed, of which twenty-eight were parents and thirty-seven were their offspring.

Tracings were made of the lateral roentgenograms, and on each tracing the salient landmarks were located and connected by straight lines. Twelve of the angles so laid out were considered particularly significant and were measured with a standard transparent protractor to the nearest one-fourth of a degree.

Because Brodie (1941) has demonstrated that the facial pattern of an individual does not change after the third month, it is justifiable to use only one headplate of an individual, taken at any age, since age does not alter the magnitude of the angles partitioning the pattern.

The angle N-S-Gn was chosen as an angle which is especially significant in cephalometric research; it is determined by the anteroposterior position and the vertical position of the chin-point, and it has particular stability in a group of stable angles. N-S-Go positions gonion anteroposteriorly, and S-Go-Gn is a measure of squareness (or lack of it) in the lower posterior part of the facial complex.

The group S-N-NS, S-N-I (I being the incisal edge of the upper central incisor), and S-N-Gn indicate the anteroposterior position of the nasal spine, the upper central incisor, and the chin-point, respectively, in relation to the anterior cranial base (sella turcica to nasion).

The group of angles "cant of palate," "cant of occlusion," "cant of Go-Gn" are measured by reading the angles formed by the line NS and each of these lines. The floor of the palate is determined by connecting PNS and NS by a straight line; the occlusal plane is determined by connecting the points

representing one-half the cusp-height posteriorly and the incisal edge of the upper central incisor anteriorly. Go-Gn may be taken as the lower border of the mandible.

The X-Y axis refers to the two diagonals S-Gn and N-Go which cross the facial pattern. The intersection of these diagonals occurs somewhere near PNS and presents four angles; one may measure either the one opening anteriorly or the one opening posteriorly.

The gonial angle is determined by drawing a line tangent to the lower border of the mandible, and one tangent to the posterior border of the mandible, and measuring the angle so formed.

A preliminary survey of the material was made by comparing the various areas bounded by the lines of the pattern in different members of the same family. This was done by superposing the individual tracings. The nasal area, for example, is bounded below by the palate (NS-PNS), above by N-S, and posteriorly by the line S-Go, when NS-PNS is extended back to it. The upper dental area is bounded above by the palate and below by the occlusal plane. The inferior dental area was also considered in a similar manner. This was an entirely subjective appraisal in which an arbitrary number was assigned to indicate the observer's estimate of similarity. Repetition of the appraisals by a second observer showed the method to be so inconsistent that it was abandoned and an effort was made to put the study on a strictly quantitative basis.

Early in the examination of the data, it was noticed that twins showed equal measurements for a certain angle, and, furthermore, that the value was exactly midway between those of the parents. In spite of the fact that this somewhat startling observation failed to appear regularly in the entire group, it was decided to determine exactly how the measurements of the offspring fell with respect to those of the parents. The values for all offspring were classified in three categories: those which were identical with one parent, those which were outside the range of the parental values (either greater than the larger of the two parental values or smaller than lesser), and those within the parental range. The third category was further analyzed to show how many values which were within the parental range fell within one-half degree of the calculated mean between the parental values.

TABLE I. DISTRIBUTION OF ANGULAR MEASUREMENTS OF OFFSPRING AS COMPARED WITH PARENTS

ANGLE	IDENTICAL WITH ONE PARENT	OUTSIDE RANGE BETWEEN TWO	INSIDE RANGE TOTAL	BETWEEN TWO: AT MEAN*
N-S-Gn	1	16	15	4
N-S-Go	4	16	12	5
S-Go-Gn	1	22	9	1
S-N-NS	3	12	17	4
S-N-I	1	19	12	4
S-N-Gn	0	20	12	3
X-Y axis	2	17	13	3
Cant of palate	3	13	16	6
Cant of occlusion	0	21	11	1
Cant of Go-Gn	1	18	13	3
N-Gn-Go	1	22	9	3
Gonial angle	3	15	11	3
Total	20	211	150	40
Per cent of total:	5.25	55.38	39.37	10.50

*Within $\frac{1}{2}$ degree of calculated mean. These frequencies are included in the total line and constitute 26.66 per cent of the total number which fell within the parental range.

The roentgenographic cephalometric method seems to be feasible for the comparison of individuals with respect to craniofacial pattern. It is particularly useful in the study of resemblances in a family, and in studies of twins, and it should be of some use in the study of any individuals of the population when type is being considered.

One could not fail to be impressed with the wide differences in facial skeletal pattern existing in twins which resemble each other closely in outward appearance.

This might be explained by the observation that eye- and skin-color and contours of soft parts are usually noted in making subjective appraisals of similarity, but it must be remembered that the cephalometric technique is as yet used only in *norma lateralis*. It might be that when correctional scales applicable to frontal headplates are available, similarity of an altogether different order might be seen from *norma frontalis*. Furthermore, the ordinary cursory examination of individuals is made from a point of view more comparable to that of the frontal headplate; it is not usual to devote much attention to the profile.

The portion of this work devoted to the method of comparing individuals will come into sharper focus when the procedure suggested is applied to a group of twins already classified as monozygotic or dizygotic by the criteria commonly in use.

The relatively low coefficients of correlation based on similarity ratings for pairs of angles bear out in different fashion the same observations made evident by the line-graphs; one would expect that variations in relation of the maxilla to the cranium would affect the angles S-N-NS and S-N-I to the same degree, since both NS and I are maxillary points. Length of the nasal spine and the relation of maxillary incisors to their bony base are additional variables, however, which affect the magnitude of these angles and reduce correlation. Variability in the position of the chin-point affects the size of the angle S-N-Gn, and this, plus the variables which affect the magnitude of angle S-N-I tends to bring the correlation between those two angles to a low value.

The use of angles in this type of study is undoubtedly valuable; one may obtain the whole story of an individual's craniofacial pattern by examining the angles established, provided all are carefully considered.

The real value of angles in studies of facial patterns is best demonstrated by undertaking to rework linear measurements in an effort to bring such measurements into the problem. In no way did the comparisons which were permitted by this process make justifiable the labor involved. Angles evoke in the mind much clearer difference between individuals and are usable as taken from the tracings without further calculations. Furthermore, every angular measurement taken may be used, whereas if converted linear measurements are employed one must sacrifice the value used as the basis of comparison. Specifically, it will be noted that no comparisons of total face-heights are made in this study; to eliminate age differences it was necessary to deal with all individuals as if total face-height equaled 100 mm. in each case.

SUMMARY

1. A system based on the angles of the craniofacial complex for the purpose of determining the degree of similarity between individuals has been presented and applied to the members of fifteen different families.

2. Twins showing pronounced outward similarity may show dissimilarity in the craniofacial pattern.

3. None of the angles studied bears a relationship to any other angle in the craniofacial complex that is precise enough to be predictable. Furthermore, no definite relationship between any particular angle and any particular side of the polygon can be said to exist; and finally, knowing that one particular side is relatively long or relatively short does not permit one to predict even roughly the length of any other side.

4. The value of this type of analysis when applied to studies of monozygotic twins and studies of facial type has been pointed out.

5. Lower face-height (Gn-NS) contributes very close to 57 per cent to total face-height in all individuals; this verifies the previous observations of Brodie.

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Medical and Surgical Relief Committee of America

For the first time since the war began, the Medical and Surgical Relief Committee, 420 Lexington Avenue, New York City, was able to send relief to Malta. The story of this shipment is an indication of the splendid results that can be accomplished when individuals and organizations unselfishly cooperate to overcome difficulties which might otherwise prove insurmountable.

The start of the story is laid in Malta, where Dr. Walter Bartolo, dentist, was unable to practice dentistry because he had no tools, no medicines; nothing, in fact, but hope and faith that men of good will still exist. He was not mistaken. His appeal to Dr. Elmer S. Best of Minneapolis, Minnesota, Advisory Chairman of the Medical and Surgical Relief Committee, and Registrar of the International College of Dentists, brought immediate results. The Committee carefully selected the instruments and supplies necessary to the foundation of an efficient dental office, including a foot drill to take care of the lack of electricity in Malta, and the people of Malta were one step nearer the achievement of dental health. It remained, however, to get the three cases of assorted supplies, valued at \$592.86, to their destination. Here again men of good will at work together produced results. The Medical and Surgical Relief Committee donated three cases of dental supplies; the Red Cross Motor Corps transported the cases to the ship's pier in New Jersey; the S/S John Lawson carried the cases to their destination, and the finance committee of the International College of Dentists voted to pay the \$155 customs duty.

Note of Interest

Dr. John W. Flanagan announces the removal of his office from the Land Title Building, Broad and Chestnut Streets, to the Medical Arts Building, N. W. Cor. 16th and Walnut Streets, Philadelphia, Pa. Telephones: LOcust 2667; TEN. 0420. Practice limited to orthodontics.

OFFICERS OF ORTHODONTIC SOCIETIES*

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*The Journal will make changes or additions to the above list when notified by the secretary-treasurer of the various societies. In the event societies desire more complete publication of the names of officers, this will be done upon receipt of the names from the secretary-treasurer.

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*The Journal will publish the names of the president and secretary-treasurer of foreign orthodontic societies if the information is sent direct to the editor, 8022 Forsythe, St. Louis 5, Mo., U. S. A.